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ELECTRIC POLARITY OF METABOLISM.

EMPIRICISM is the bugbear of all true scientists, and, it is to be hoped, of electricians in particular. Accuracy, based upon proved theory, is the aim of all who seriously undertake work in one or other of the many branches of applied electricity. This by no means excludes a due attention to the, one time, mystic symbol which an eminent engineer stated should always form part of every working formula.

The ◇CS◇ (common sense) must of course play a leading part in applying formulæ and theoretical laws to everyday practice. Most of the branches of applied electricity have now, by a system of evolution, reached the happy stage where approximate accuracy has supplanted empiricism, but this can hardly be said to be the case in electro-therapeutics. It is, therefore, with considerable satisfaction that we welcome an attempt recently made by Dr. W. J. Morton, in a communication to the New York *Medical Record*, to establish a "basis and guide for medical treatment by electrical energy." The basis he suggests is a "possible electric polarity of metabolism," and his reasons for the suggestion are carefully thought out and put forward with an attention to the details of the subject which make his communication interesting to the physicist, to the physiologist and the physician alike. It has long been known that currents of electricity are generated within the body, or, rather, that differences of potential are found which, when connected by an external circuit, cause currents to flow. Many investigators have shown evidence of this, and Dr. Waller's beautiful demonstration of the electrical action of the human heart may be mentioned as an illustration. Mr. Newman Lawrence in a lecture before the Home Reading Union in July, 1890, stated that he hoped and expected the time was not far distant when "further knowledge of the electric condition of the body would lead to improved and more accurate diagnosis of disease, and more detailed evidence of the effect upon the body currents of external currents would tend towards more efficient and rapid cure of disease."

Dr. Morton's conclusions lead him to put forth a law of electro-therapeutics which is a curious fulfilment of the hope just referred to. In elaborating the law, the author goes on to consider if the problem of finding "some clue furnished by the actual processes of health and disease in living tissue, which shall serve as a guide to treatment by electricity" . . . "some explicable way out of the uncertainties among which we grope," may not be solved "by appealing to an electro-chemical basis of normal and morbid processes in living organisms." Further, if there may not be founded thereon "a special and invariable law, which may serve as a definite guide to electro-therapeutics." He then goes on to say that as one "transformation of the chemical energy of the process of living is into electric

energy, we must admit that both physiological and pathological processes are, when such transformation occurs, electromotive sources or focuses." And by using for analogy the well-known fact of the action of the ordinary galvanic cell starting from the electro-positive zinc in contact with the electrolyte, he argues that "in the living animal body, heat and electric energy are the direct results of oxidation or combustion (katabolism), and the starting point of this activity is an electro-positive starting point. This brings us to the fundamental point of his suggestion, viz., "That all active centres of living, of chemical affinity in living tissue, of metabolism, constructive and destructive, of physiological and pathological processes in living tissue, in short, all such centres of health and of disease are initially electro-positive to some other electro-negative portion of the same tissue or surrounding or neighbouring tissue and media." In applying his law, Dr. Morton states that disease is "a perversion of metabolism. . . . In health the balance is maintained; in disease it would range above or below this standard of stability; the chemical exchanges would be excessive or deficient, over-active or under-active, but at all events katabolic, destructive, oxidising, and therefore electro-positive." "It is at this point that the modifying (curative or non-curative) interference of the physician's extraneous electrical current can be exactly applied." The article then goes on to strengthen the position taken up by dealing somewhat minutely with the strictly physiological aspect of the subject, and in a manner scarcely free from verbiage. Reliance is placed upon the existence of a "current of repose." This reliance seems scarcely warranted in the face of the fact that Messrs. Landois and Stirling declare "that passive, uninjured, and absolutely fresh nerve and muscle are absolutely devoid of current." With this exception, it does not appear that the facts made use of can be seriously called in question, while the conclusions seem reasonable, and, if not proved, are at least justifiable hypotheses. Dr. Morton certainly goes to the root of the matter, for he takes as his basis the action of the single living animal cell, and argues upwards to the whole process of metabolism and the normal and morbid changes which form the condition, respectively, of health and disease. If the law set forth will stand the test of actual experience, what a brilliant prospect it holds out for the maintenance of health by electrical means. The electro-therapeutist will no longer be compelled, by the force of circumstances, "to treat the unknown by the aid of the unknown." He will direct a definite measured energy in a definite direction to correct the over activity, or to stimulate and aid the flagging under activity of metabolic action, as may be needed. The oft-complained of uncertainty of electric treatment will be reduced to a minimum, if not entirely eliminated. The nauseous draught and the penetrating pill will cease to trouble our existence, and health to enjoy may be once more the lot of all. This may be the dream of an enthusiast, but electricity to-day performs many a beneficial act which a few years ago existed only in the imagination of enthusiasts. Even now, with visions appearing on the horizon of electric light without lamps from Tesla's experiments, and electric communication without wires from those of Preece, who shall say that a system of *exact electro-therapeutics* may not be in general practice in the very near future?

ELECTRIC PYROMETRY.

A PROMINENT feature of the great industries of to-day is the demand for scientific accuracy in every method and operation; the empirical is giving place to the quantitative, with the result that economies are effected, and better quality is attained, than ever the last generation dreamed of. It is difficult to say whether this is due to the press of competition or to the spread of technical education, for in all probability these two factors are too closely related to each other to be capable of differentiation.

The demand for accuracy is typified in those industries which involve the employment of high temperatures. We are beginning to recognise that it is only by being able to determine and to control the heat at which fuel is burned, metal run from its ores and worked into useful forms, that we may expect to reap a full profit. Now, ordinary thermometers, on account of their limited range of action, &c., are useless, and consequently other methods of heat measurement have been resorted to, which are included under the heading of pyrometry.

Pyrometers are based on various principles, for nearly the whole range of physics has been searched for principles which could be utilised in producing a useful apparatus. Some are based on changes in the volumes of bodies (*e.g.*, Daniell's and Wedgewood's), others on the known melting points of metals and alloys (*e.g.*, Ducomet's), on calorimetric methods, similar to the determination of specific heat by the "method of mixtures," on the partial rotation of polarised light by a quartz-plate (Mesuré and Noel), &c., whilst the more modern systems of high temperature measurement are based upon the production of thermo-electric currents, and on changes in the electrical resistance of conductors. These last are at once the most reliable and the most delicate of all high temperature apparatus, and are coming to the front so fast that we expect to see all other systems giving place to them.

During the past few months we have repeatedly called attention to methods of what may be termed electric pyrometry, having dealt with the researches of Le Chatelier, Carl Barus, and others. We have now to notice what is, perhaps, the most elegant, and at the same time practical system that has yet been devised, namely, the electric telephone pyrometer of Hartmann and Braun.

The instrument presents the following essential features:—A platinum spiral—the relative electrical resistance and the variation of the same with increased temperature has been accurately determined—is placed in the lower part of an iron tube, which serves as a shield and extends to some distance beyond the spiral, which portion is introduced into the furnace. The ends of the spiral are joined to binding posts at the outer extremity of the tube by thick platinum conductors, and then connected with a Wheatstone bridge. Two of the three known resistances are altered, until their ratio is the same as that between the pyrometer and the third resistance, and then the temperature can be determined. [In principle it will be recognised that this pyrometer presents some points in common with that described by Siemens, *vide* British Association Report, 1872, page 134.] The equilibrium between the above ratios is made apparent by the use of a galvanometer and small battery. If the apparatus is exposed to jarring, however, the galvanometer is

replaced by a telephone, a small induction coil furnishing the necessary current.

The instrument is made in a portable form, and is distinct from one intended for mere laboratory experiment. The galvanometer is of the Deprez and D'Arsonval type; it can be set up quickly, and is very suitable for this kind of work. This pyrometer can obviously be used for measuring temperatures, the *loci* of which are remote from the point of observation.

Electricity in the Treatment of Insomnia.

IN the *Lancet* of June 10th, Dr. W. S. Hedley gives, in considerable detail, an account of a typical case of insomnia successfully treated by electricity. The form of insomnia dealt with is that which usually accompanies neurasthenia or debility of the nervous centres. The symptoms of the disease are fully described, and, alas, are those with which many men are only too well acquainted in these high pressure times. Dr. Hedley says the condition is "sometimes called a neurosis of modern life; but it is no modern picture—it is a modern copy of an old master. It is, in fact, a nosological grouping as old as the days of Hippocrates." The treatment adopted consisted of both local and general applications, mostly with continuous currents. The patient at first showed considerable dread of the current. This is described as "the usual initial difficulty—such patients are hypersensitive always, and shrink from a proceeding which they are sometimes accustomed to associate with a shock." The general treatment took the form of dipolar electric baths, commencing at 50 m.a. for 5 minutes, and concluding with 150 m.a. for 15 minutes. The local applications were made to the head in various ways with a current from $2\frac{3}{4}$ m.a. to 5 m.a. passed for 5 minutes. The result was that the patient's sleep steadily improved till it reached an average of 6 hours out of the 24; "that is to say that after seven weeks of treatment, consisting of about thirty séances and twelve baths, sleep was practically restored. Not only this, but the general health and moral condition were strikingly improved. Instead of dark forebodings and pessimistic views, he talked cheerfully and hopefully of going back to work again."

Magnetisation Phenomena: Nickel.

The magnetism of iron, nickel, and cobalt, is known to change under the influence of stretching forces. Villari first observed a special behaviour of iron in reference to this attribute, namely, that with moderately strong magnetisation, small stretching forces increase the magnetism, while larger forces diminish it; thus, the strength of the magnetism is graphically represented as a function of the load, the ordinate of the curve first increasing up to a maximum and then diminishing to far below the original value. The point of the curve at which the ordinate again reached the original value is named Villari's critical point. In nickel, this property has, hitherto, not been observed: in this case it was assumed that the magnetism decreases with increasing load, But with strongly magnetised soft iron, also, with small load, the original increase of the magnetism vanishes, and it was thought probable that, with sufficiently weak magnetisation, nickel, also, possesses Villari's critical point. Experiments recently conducted by Prof. Heydweiller have confirmed this expectation completely. Details of his investigation, which was conducted with extremely sensitive apparatus, are given in this month's *Philosophical Magazine*, p. 469—470. With small strength of magnetisation, under 2 C.G.S. units, and with the smallest load, soft annealed nickel shows a small decrease of magnetism, with somewhat larger an increase which may rise 26 per cent. of the total magnetisation, and finally, again, a decrease with increasing load. With stronger magnetisation, the increase becomes continually smaller; moreover, after effects of the preceding loading and phenomena of hysteresis, show themselves to a considerable degree. Hard drawn nickel presents the same phenomena with much stronger magnetisation still, even though in a fuller degree. It may, therefore, be asserted on examining the numerical results that, with reference to these phenomena, the behaviour of nickel agrees well with that of iron, quantitatively but not qualitatively.

Note on Equipotential Lines: Hall's Phenomenon.

THERE is an interesting series of photographs in *Wiedemann's Annalen der Physik und Chemie* which has an important bearing on the phenomenon of Hall, which just now appears to be attracting a considerable amount of attention in scientific circles. These photographs represent the equipotential lines due to a current flowing through a metallic plate and are the result of an investigation by E. Lommel. The method by means of which they are obtained is as follows:—A current is passed through a thin copper plate, fine iron filings being distributed on the surface; these map out the equipotential lines, which may then be drawn or photographed. In endeavouring to throw some light upon Hall's phenomenon, Lommel argues as follows:—If 2ε represent the difference of potential between two selected points on the copper plate, M the strength of the magnetic field normal to the direction of the current in this plate (Hall's method), then

$$2\varepsilon = K\,J\,M,$$

where K is a sort of "friction coefficient" which depends upon the material of the plate employed, and J the strength of the current flowing through the plate. Now, the resistance of the plate, which is practically what is meant by K, is proportional to its section and also to its thickness. Lommel therefore assumes K a constant and deduces

$$\varepsilon = K \cdot \frac{J\,M}{r\,\delta}$$

where r is the resistance of the galvanometer and δ the thickness of the copper plate. This formula, he is of opinion, correctly expresses the Hall effect. Further details may be found in the original paper of v. *Wied. Ann.*, 1893, pages 462—466.

The Potential Differences between Metals and Bases.

ELECTRO-CHEMICAL investigations are becoming more and more popular amongst those scientists who make time for original research; these are of a specially fascinating nature, since every fragment of knowledge won must have some bearing upon the elucidation of those deep problems concerning chemical affinity and the relation which chemical energy bears to electrical energy. F. Exner has recently determined the potential differences between a large number of metals and bases, making use of a method employed for a similar determination in the case of acids. He finds that the metals all became negatively charged, and the solutions positively; whilst the potential differences are of the same order of magnitude as those observed for solutions of acids and salts. The values increase with potash and soda very considerably, with rise in concentration with all metals except magnesium, the values for which are nearly all lower than those obtained in pure water. The occurrence of a maximum at a certain concentration was not observed, except in the two cases of mercury and tin in ammonia solution. With the acids the potential differences were found to vary periodically with the atomic weights of the metals, so that certain metals always gave maximum and minimum value; a similar behaviour is to be observed in the case of the bases. With the aid of the numbers obtained for the potential differences between metals and acids and metals and bases, Exner has been able to determine the potential differences between acids and bases. He found that bases in contact with acids became negatively charged, and that acids, therefore, behave towards bases as they do towards metals, with one exception, viz., in the case of acetic acid and ammonia, when the acid in very concentrated solution became feebly negative. Concentration exercises a marked effect in all cases, a constant increase in the difference of potential with increase of concentration being observed for hydrochloric, hydrofluoric, and acetic acids. Other cases of exception are noticed, and the quantitative results are given in a paper which may be consulted in the *Monatshefte*, Vol. xiii., p. 851.

ARC LIGHTING.

BY E. TREMLETT CARTER.

(*Continued from page* 738).

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V.

8. *Aerial Lines.*—Power cables are carried on poles overhead when the distance over which the power is to be transmitted is such that the cost of placing the cables in conduits is prohibitive, or where the cables pass across country in which there is little or no danger to life by having the conductors so arranged. Unless the weight of cable is large, the cost of an aerial line is very much smaller than of a buried line, and at high voltage many hundreds of horse-power may be transmitted before it becomes cheaper to adopt the conduit system. The chief reasons why overhead lines are not adopted in large towns, and why there is a restrictive legislation against them (speaking only now of light and power cables), are on account of the long spans which must be used in crossing streets, and the consequent heavy strain on the wire, with the risk of killing passengers in the street by the cable breaking, and because of the liability of the bare wires to be accidentally or ignorantly touched by persons who might have access to them, the shock from such contact being fatal at the voltages commonly used. The influence of the weather upon overhead lines is an engineering reason why they are only used where price prohibits the alternative system. Snow will not settle on the cables when they are working, because of their high temperature; but it often freezes on them when they are not carrying current, and may break them down; lightning flashes may strike the line, and, even with the best protecting devices, may cause some injury; wind pressure during a storm may overstrain the line and break it. Then, again, the insulation of the line at the posts is difficult to maintain in a damp atmosphere, or where insects may spin their webs inside the insulators. Lastly, the important fact that the line will have to carry its own weight, unless a bearer line is used, and the further fact that the best conductors are weak mechanically, almost in inverse proportion of their conductivity, render it difficult to construct a strong and electrically efficient overhead line. Notwithstanding these points, it is possible, by careful attention to every detail, to design an aerial line for very large power, which shall be durable and efficient. We shall now consider these details in order.

The choice of the conducting material is the first important step. The desirable qualities are:—High conductivity, great tensile strength, low density or weight per unit volume, durability, and cheapness. The following table gives some data for most of the materials proposed for this work:—

Material of conductor.	Conductivity.	Tensile breaking strength.
Pure copper	100	39,000
Hard drawn copper	97	61,000
Silicon Bronze, Mark A	97	63,200
" " Mark B	80	79,500
Aluminium	56	30,000
Phosphor bronze	26	101,000
Swedish hammered iron	16·5	50,700
Swedish Bessemer steel	16·0	56,200
Siemens-Martin steel	13·3	59,000

It will be observed that in general the strength increases as the conductivity diminishes. Other things being equal, that material is best for which the product of the conductivity into the strength is a maximum; but in practice the other things are not generally equal, and cost and density affect the conclusions. A very light substance such as aluminium might be useful if it were not so expensive, and if its tensile strength were greater. The low conductivity of this material involves a large diameter, which would oppose a large surface to wind pressure. Its small tensile strength would necessitate small spans and frequent poles, which would be expensive. "As a general rule," says Mr. Kapp, "copper is preferable to iron or steel, and phosphor or silicon bronze is preferable to pure copper." The objection to iron and steel is the large diameter and numerous poles involved, because of the high specific resistance of the material; the objection to copper, notwithstanding its low specific resistance, is practically the same, namely, the numerous poles required, on account of the small strength of the metal. Hard drawn copper is preferable to pure or any form of annealed copper.

We are not, however, compelled to design the overhead cable on the above lines; for we may adopt the practice of using two distinct wires, one to carry the current the other to support the first. The former may then be of high conductivity copper, and the latter of some strong material, such as steel. The supporting line is usually called the *bearer* wire. If the bearer is carefully insulated at every post there is no objection to the use of bearers for uncovered copper conductors; but, as a rule, bearers are used only where the cable is continuously insulated. It may be found that in some cases it will pay to adopt a bearer and bare conductor, rather than a conductor alone, as in crossing a wide river with bare copper mains; but in most cases it is cheaper to use a thicker single wire of some material, such as silicon bronze, which will do the work of both. Besides this, having a bare wire supported by an insulated bearer doubles the leakage of current at the poles. Aerial lines are continuously insulated where there is any chance of their coming into contact with neighbouring conductors, or where they may be reached by the public. It is a disputed point whether such lines should rely upon the continuous insulation alone, or whether the bearer should also be supported on insulators. Earthing the bearer has the defect that it at once puts any flaw in any part of the cable into direct communication with the earth, and encourages leakage and breakdown. Insulating the bearer has the defect that it puts an insulated bare wire into communication with a high voltage conductor directly any fault appears in the continuous insulation; and this makes the bearer as dangerous as the high voltage conductor would be if quite uncovered. Economy demands the insulator for the bearer; personal risk prohibits it when the voltage is very high. Where alternating currents are carried overhead by means of bearers, it will be necessary to have a concentric cable with one bearer, otherwise the induction on the bearers will cause great waste of power.

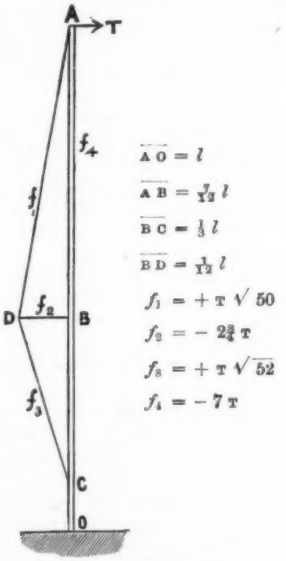
Having selected the method of running the cable and the quality of the material to be used, it will next be necessary to determine the proper diameter. This will not be determined simply on the basis of its current-carrying power or by the economic law, since the stresses arising from the handling which the line receives in erection, and which are maintained at the supports when it is fixed, will make it necessary to fix a minimum diameter. Copper wire smaller than No. 12 or 14 S.W.G. should not be used, and any section requiring a larger area than that of No. 10 S.W.G. should be stranded. Above this size, the section may be fixed by the economic law or by the maximum amount of drop permissible, as may be desired. Silicon bronze wires are sometimes run at as small a diameter as 2 millimetres; and the smallest size of iron wire permitted by the Post Office is No. 16. Stranded wire has an advantage in some places on account of the absence of humming at the poles, which occurs when so-called solid wire is used.

It will now be necessary to select the poles, to determine the amount of load which each will support in bending and crushing, and to find the distance which the poles must be placed apart in order to get the required minimum of sag without overstraining either the cables or the poles. First, as to the poles: these may be of creosoted timber or of iron or steel. Timber poles may best be selected from the local timbers, and the kind of tree used will depend largely on the locality. The timber should be tough, durable, and free from knots, and the fibres should be long and straight. Creosoting is resorted to in order to preserve the wood from decay. In this country larch, Scotch fir and Norwegian fir are very commonly used. Under the Board of Trade regulation, the length of the pole must be such that the wire nowhere falls within 20 feet of the ground, except at the points where power is taken into buildings. Allowing 5 feet at the end for bedding in the ground, and 6 feet as the maximum sag when the cable is working in summer, the pole will require to be from 31 feet upwards in length, or 26 feet

above the ground line. The minimum diameter at the ground line for a timber pole of this size is 8 inches, and 5 inches at the top of the pole. Above this size, the pole is designed to have a section which will give a factor of safety of at least 12 under the ordinary working stress, a wind pressure of 50 lbs. per square foot being taken (Board of Trade). By suitable stays in the form of tie rods attached to the top of the rod, the strain may be resolved into a direct downward thrust on the pole; but if such ties are not used, and there is any cross thrust at the top of the pole, the bending action will require a stouter pole to be used. Heavily loaded poles should on this account always be stayed by tie rods or stranded iron cable; more lightly loaded poles may be stayed by a wooden strut placed about 4 or 5 feet above the ground line and well bedded. Where only one tie rod or only one strut is used it must be placed in the plane of the resultant thrust on the top of the pole; the former being placed on the opposite side to the direction of the thrust, with respect to the pole, and the latter on the same side. Thus, if the thrust is due south, the tie will be fixed in the ground to the north, or the strut to the south, of the pole. Where two ties are used they will be in planes which make an equal angle with the plane of the thrust, and on the opposite side of the pole to the thrust. Two ties must be used if the pole is to be protected where the thrust is liable to shift in direction. The crushing strength of timber poles may be taken as approximately equal to—

$$C = \frac{63{\cdot}7\ D^3}{L}$$

where C is the stress in pounds, D is the diameter in inches at the ground line, and L is the height in feet above the ground at which the thrust is applied. One-twelfth of this is the working strength of the pole. Occasionally the down thrust on a pole is so great that it will require to be stiffened, so as to bring its moment of resistance to bending up to the required figure. Fig. 9 shows the mode of stiffening a wooden pole, and indicates the magnitude of the stresses in



T = Thrust; + = Tension; − = Compression.

FIG. 9.

the parts. It may here be mentioned that the solution of the stresses in the ties and struts as well as in such stiffening rods can be obtained by simple graphic methods which we have not space to describe here. Fig. 10 shows the modes of bedding a wooden pole and strut, together with the anchorage for a ground tie. For convenience the strut and tie are shown in the same figure, though they would not often occur at the same pole; and for the same reason the tie is drawn at too sharp an angle to the pole. In practice the angle of the tie with the vertical should be large, so as to put as little stress as possible on it. It should not be less than 40°. The tie is anchored to a cross baulk of timber which is buried about 5 feet below the ground if the soil is stiff, and deeper if it is light. The strut is bedded in large stones loosely thrown into the pit, and has its lower end butted against a large flat stone. The pole itself is bedded in the same manner as the strut.

Metal poles are usually of hollow wrought-iron or steel, set in standards of cast-iron. They are lighter, stronger, and more durable than timber, besides having a more artistic appearance. The main body of the pole consists of two tapered tubes socketed together by means of a screw joint of sufficient stiffness to withstand the side thrusts. To

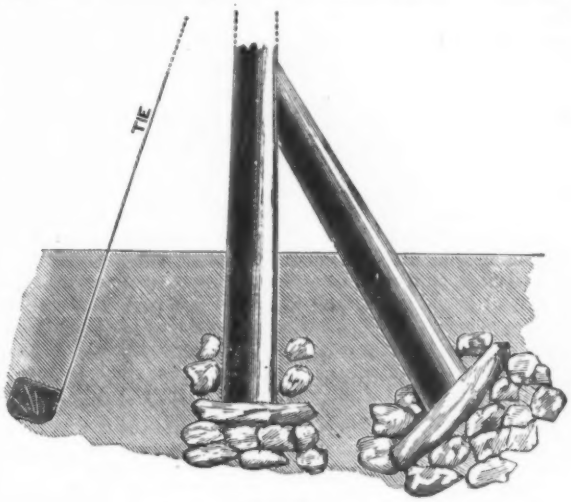


FIG. 10.

the upper end the insulator brackets are bolted; and the lower end is socketed into the cast-iron standard, which usually stands about 3 feet above the ground. The lower end of this standard, which is hollow, is cottered into a cast-iron foundation plate having wide flanges to stiffen the pole in its bed. This arrangement is shown in fig. 11. The

FIG. 11.

safe crushing strength of a wrought-iron pole may be represented by the formula

$$C = 80\ L\ .\ \frac{D^4 - d^4}{D}$$

Where D is the outer diameter, d is the inner diameter, in inches at the top of the standard, L is the height above the top of the standard at which the load is applied, in feet, and C is the safe strength in pounds. The cast-iron standard should have at least four times the section of metal than the lower end of the wrought-iron tube, and should have at least twice the thickness of this, whichever is the greater. It is inadvisable that the thickness of the standard should be less

than $\frac{3}{4}$ inch; or that the foundation plate should be less than 1 inch in thickness, unless stiffened with ribs. On straight lengths of line these poles do not require to be tied; but on curves, or where the line makes a horizontal angle at the pole, stranded iron wire ties should be used, as in the case of wooden poles.

Wind pressure exerts an average maximum force of about 19 lbs. per square foot in this country; and the storm maximum is considerably under 50 lbs. It is necessary to assume the latter figure in all structures that are designed under Board of Trade regulations; in which case the side thrust on a round pole must be taken as

$$P = 0{\cdot}05\ p\ .\ D\ .\ L = 2{\cdot}5\ D\ .\ L.$$

Where P is the total pressure on the pole, in pounds, D is the diameter of the pole at the middle, in inches, and L is the length of the pole, in feet. The constant 0·05 is a coefficient for cylindrical surfaces, and applies equally to the poles, conductors, and bearer wires. This wind force may be multiplied by *half* the length of the pole to obtain its bending action. In addition, the windage on the wires must be estimated from the same formula, and the force on all these multiplied by the *total* length of the pole to get the bending moment due to the windage on the wires. The two moments must be added, and the pole stayed sufficiently to withstand their combined action. We now come to consider the distances apart at which poles must be placed.

(To be continued.)

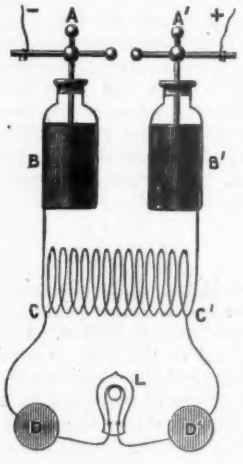
THE PHYSIOLOGICAL EFFECTS OF ELECTRICAL CURRENTS OF HIGH FREQUENCY.*

By H. LEWIS JONES, M.D.Cantab., M.R.C.P.,
Medical Officer in charge of the Electrical Department,
St. Bartholomew's Hospital.

THE application to medicine of electrical currents of great rapidity of alternation, or high frequency currents, as they are commonly called, has occupied the minds of medical men to a great extent during the past 12 months. In France especially is this the case, where D'Arsonval has given much study to this difficult subject. The demonstrations which were given at the Royal Institution by Tesla in the spring of last year left an impression upon the minds of many people that enormous voltages were harmless to the human body if only they could be made to alternate with sufficient rapidity, and people were astounded at the spectacle of a lecturer placing himself in a circuit carrying a current alternating some hundreds of thousands of times per second, at a pressure of many thousands of volts. These experiments, coming not long after the accounts of the execution of criminals by electricity in America with pressures of 1,200 or 1,500 volts, and compared with the occasional notices in the newspapers of fatal accidents to workmen engaged upon electric light cables at 1,000 volts, made it seem as though the rapidity of alternation was the factor which protected Tesla from injury by the enormously high voltages which he was handling. The same view is taken by D'Arsonval in his papers before the Société de Biologie. He there describes an apparatus (see sketch†) consisting of an induction coil supplying current to Leyden jars, the jars being made to discharge through a circuit including a helix of ten to fifteen turns of thick wire and an air gap. In this way there is set up in the circuit a succession of sudden rushes of current, which oscillate hundreds of thousands or even millions of times per second, the rate being determined by the Leyden jars; and the wire helix becomes the seat of electro-magnetic induction effects, comparable exactly to the induced primary currents of a medical induction coil, but very much more intense. These induced currents of the helix are the subject of D'Arsonval's experiments. By attaching wires to the beginning and end of the helix, the induced currents or extra currents can be led off; their energy was sufficient to bring to full incandescence a lamp requiring two ampères to light it, and it was therefore assumed that they had a magnitude of 2 ampères. The electromotive force of the currents was at least 8,000 or 10,000 volts, because they were able to leap across an air gap of several millimetres, and yet their effect upon the tissues of the body was very slight; in fact, they were hardly felt.

Now it is certain that a current of far less than 1 ampère, either steady or alternating 20, 50, or 100 times per second, would produce unbearable and dangerous shocks in its passage through the tissues; and the inference drawn is that the extreme frequency of alternation can render a current of dangerous magnitude innocuous. But I am not satisfied that such an inference is a proper one, for the following reasons:—

1. A Leyden jar discharging through the body, produces effects which are painful and severe, as all who have felt them will agree; but yet this is a discharge of high frequency of alternation; in fact, it is by the Leyden jars in the circuit



that the oscillatory character and the rapid rate of alternation of the discharge is determined. Oliver Lodge gives the rate of oscillation for a pint-sized Leyden jar at ten million per second; for jars of greater capacity the rate is less rapid.

2. The high frequency and high potential discharges of Tesla's apparatus are not altogether harmless, but can produce severe shocks and can kill small animals, as Elihu Thomson has shown. The discharges from the terminals of such an apparatus can produce severe muscular contractions even with the resistance of a considerable air space interposed in the circuit; so much so, that in some recent experiments which the writer was enabled to make through the kindness of Mr. Campbell Swinton, it was considered prudent to proceed no further with the experiment of actually touching both the terminals of the coil at once.

3. It is very doubtful whether D'Arsonval's estimation of the magnitude of the current of his apparatus is correct. The incandescence of a lamp filament with currents of high frequency has been recently under discussion in some of the electrical journals, and a very satisfactory explanation of the phenomenon has been forthcoming.* It is well known that for alternating currents the resistance of a conductor is greater than it is for steady currents, and the increase of resistance rises rapidly as the rate of alternation becomes greater; and with frequencies approaching one million per second, the effective resistance of the lamp used by D'Arsonval would be raised enormously; this would require the energy needed to bring it to incandescence to be applied at a proportionately higher voltage, while the magnitude of the current would be lessened in an equal degree. For example, the energy of 2 ampères at 100 volts is the same in amount as that of 0·02 of an ampère (20 milliampères) at 10,000 volts.

We are, therefore, able to say that the current which raised D'Arsonval's two-ampère lamp to bright incandescence was very much less than 2 ampères, and was probably only a few milliampères, and herein lies the pith of the whole question. The experiments with high frequency currents of high tension are harmless if the magnitude of the current is small, and as the high potential is, in fact, obtained at the expense

* *British Medical Journal.*

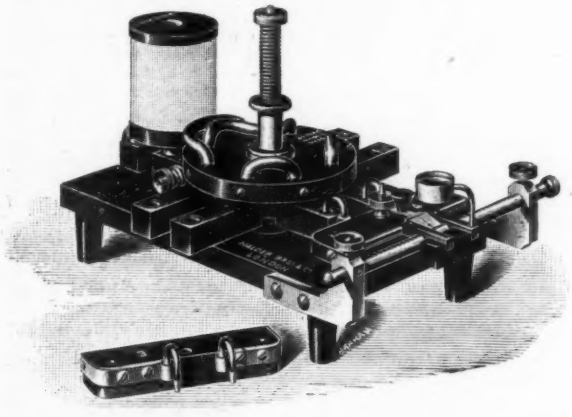
† For details see ELECTRICAL REVIEW for April 28th, page 490.

* *Electrician*, December, 1892.

of the current, this latter diminishes in proportion as the potential is raised by each successive step-up in the transforming apparatus. For the present, it may be taken as not yet proved that high frequency of alternation can render electrical currents harmless; and it may still be accepted that the effect produced by the passage of a current through living tissues depends primarily upon the magnitude of the current, as measured in ampères, which is made to traverse them, and upon its density or concentration therein.

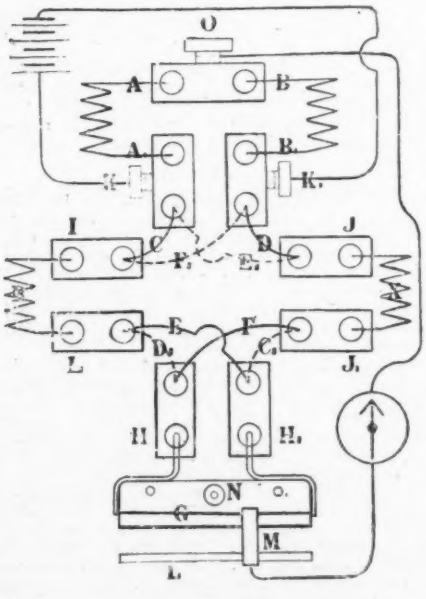
A BRIDGE AND COMMUTATOR FOR COMPARING RESISTANCE COILS BY PROF. CAREY-FOSTER'S METHOD.

THE instrument shown (manufactured by Messrs. Nalder Bros.), fulfils the purpose of commutating the resistances to be compared with respect to the ratio resistance coils and a series of bridge wires, to be used according to the value of the coils under comparison. It consists of copper



bars mounted on an ebonite base, and furnished with mercury cups for making the necessary contacts.

At A, A_1, and B, B_1, are the cups for the ratio coils



which are wound upon one bobbin and usually of the value 1^{ω}, 10^{ω}, 100^{ω}, and $1{,}000^{\omega}$ on each side. At I, I_1, and J, J_1 are placed the resistances whose difference is to be measured, and at G is the bridge wire mounted on a detachable frame, with the key, M, which runs on the divided rod, L, for making contact.

C, D, E, F, show the commutator connections in the first position, and after commutation in the position, C_1, D_1, E_1, F_1, as indicated by the dotted lines.

In order to commutate the coils R and X, the ebonite plate upon which the connections, C, D, E, F, are mounted, is drawn up against the spring which presses the contacts into their respective cups, until the guide pin is lifted out of its recess, the plate can then be turned through 180 degrees till the contacts are in the position shown by the dotted lines marked C_1, D_1, E_1, F_1; the galvanometer is then brought to zero by moving the contact key, M, into another position on its wire.

The battery connections are shown at K, K, and those of the galvanometer at M, O.

In order to obtain a wide range of measurement, instead of using a long wire, a number of short bridge wires are provided, usually about ten, though, if necessary, this number need not be considered the limit.

The plate upon which each wire is mounted is detachable as already stated, and in addition to the milled head, H, two steady pins are fixed in the base of the commutator so that it or any of the series can always be replaced accurately in position with respect to the scale and key.

A considerable variation of resistance of the short bridge wires shown will not vitiate the accuracy of the measurement.

This apparatus has been in use for the last five years substantially as now shown.

TELEPHONE COMPANIES AND ELECTRIC TRACTION.

(*Continued from page* 747.)

SUMMARY OF EVIDENCE.

The fourth day's proceedings were opened on Thursday week. The evidence given since our last issue has been chiefly remarkable for the way in which the telephone companies' officials have been quietly contradicted. The testimony of witnesses for the traction cause has been clear and emphatic.

Mr. Langdon, of the Midland Railway Company, gave some strong evidence against the electric tramways. The block signals had been seriously affected at Walsall at a point three miles from where the tramway (the South Staffs. line) crossed the railway. He considered that the only way of working railways with safety was to prevent high currents entering the earth. If electric traction became general, in his opinion, the company's wires would be so much affected that they would have to spend about £17,000 or £18,000 to make them safe. It was made clear that Mr. Langdon's own view of the matter is that the tramway company and the railway companies should both put down metallic returns.

Mr. Spagnoletti followed in somewhat the same strain, with the exception that he would have both wires insulated.

Mr. Swinburne very soon gave his opinion of the telephones. He looked upon the single wire system in telephones as a cheap and bad system. All the interference to which telephones were liable he attributed to the use of a single wire. He dealt some smart raps to the telephone companies in the course of his evidence. He dwelt upon the advantages of electric traction; as to disturbing telephones, well the authorities had come to the conclusion that the roads were meant for traction and not for talking through. It would not be practical to make a tramway so perfect that it would not disturb telephones with earth returns. No engineer would undertake to put up a tram line where he was liable to an injunction for leakage. Induction, he considered, was the greatest source of trouble in telephones. In his opinion the expense of duplication of the telephones would not be great.

Mr. Crompton said the protective clauses had prevented electric traction from spreading. His firm, in common with others, had been asked by the Glasgow Corporation to take the responsibility of complying with the protective clause in their provisional order, and had found themselves utterly unable to do so. The Buda-Pesth system of electric traction

would be impracticable in England. The point used with great effect by other witnesses, that the use of another conductor would enable them to use higher pressure, was combatted vigorously by Mr. Crompton. The Board of Trade, in his opinion, would not give permission to use a higher pressure. To adopt the Buda-Pesth system would mean taking up the street to a depth of 45 feet, and a width of 45 feet. Besides which the leakage on a system like the Buda-Pesth would be very great in England on account of the damper nature of the climate. To enforce a point as to the difficulty of crossings on this system, Mr. Crompton said that in Buda-Pesth it cost £4,000 a mile, but if they were to take such places as King's Cross, where there were many lines, it would cost about £10,000.

Mr. A. R. Bennett, at the beginning of his evidence, was anxious to impress upon the Committee that he was not a voluntary witness. The cost of a new exchange on the metallic circuit, if designed at the beginning exclusively for metallic circuit, would not cost appreciably more than a single wire exchange. To alter the single wire to the double would require very great care, but it could be done without interfering with the switchboards.

Mr. Alexander Siemens was the next practical expert, who spoke of the single wire telephone systems in Australia, on some of which they had had so much trouble that they were adopting a metallic return. The metallic circuits of telephones did not necessarily mean the doubling of all the wires; but if induction were to be got rid of then they must adopt double wires. In the Leeds case the chief difficulty was the effect of induction. He corroborated Mr. Crompton's statement as to the enhanced cost in England of a system like the Buda-Pesth. He gave a side-light on the way the Siemens firm had endeavoured to push the tramway business in England; they had applied to the Bradford Corporation for permission to introduce the Buda-Pesth system there, but without success.

Mr. Greathead gave some most interesting and instructive evidence as to the extraordinary increase of passengers in London during the past few years. In 1866 when the Metropolitan Railway Company's system was opened it carried 11½ millions passengers per annum, and the London General Omnibus Company carried 41 millions. Nowadays, however, 490 millions were carried, and this was exclusive of the great railway companies. He dwelt upon what he called the notorious fact that the present facilities for getting people in and out of London were bad and insufficient. The tramways carried 200 million people, but, on account of the horses, they could not go above 5 miles an hour; electric traction would mean an increased speed of 50 per cent., bringing up the travelling rate to 7½ miles an hour. He gave figures as to increase of cost if they were to adopt an insulated return on the Central London Railway. It would mean an increased expenditure of £40,000 per mile.

After Mr. Parsons, of the Thomson-Houston Company, who gave the Committee some idea of what his firm had done in the way of electric traction, came the municipal authorities. It was clearly evident that the Town Councils have more regard for traction than telephones, for Mr. Cooper, Town Clerk of Walsall, boldly declared that if they in Walsall had to choose between doing away with the tramway and the telephones, the telephones must go. The Mayor of Leeds also gave evidence in support of the traction interests, speaking from his Corporation's experience of the tramway at Leeds, they were much in favour of it.

Speeches of Counsel on Tuesday concluded the sittings of the Committee. We shall await with interest the report which will, in all probability, be issued during the month of July.

FOURTH DAY.

THE Joint Committee of the Houses of Lords and Commons sat for the fourth time for receiving evidence to assist them in considering the course of procedure in relation to the arrangement of protective clauses for telephone and other companies against the operation of electric railways and tramways. Lord Cross, the chairman, presided. The following are the members of the committee:—Lord Clifford of Chudleigh, Lord Rosse, Lord Russell, Mr. Brunner, Major Darwin, Mr. Forwood, Mr. Molloy, Sir Bernhard Samuelson.

The particular interests concerned were represented as follows:—National Telephone Company, Mr. Pember, Q.C., Mr. Fletcher Moulton, Q.C., Mr. Roger Wallace; Railway Companies, Mr. Pope, Q.C., Mr. Moulton, Q.C., Mr. Ernest Moon; Electric Tramways Companies and Electric Underground Railway Companies, Mr. Cripps, Q.C., Mr. Graham; Municipal Corporations, Mr. Balfour Browne, Q.C., Mr. Worsley Taylor, Q.C.; Tramway Institute, Mr. Hans Hamilton; Gas and Water Companies, Mr. Pope, Q.C., with him, for the gas companies, Mr. Danckwerts; Counsel also appeared for the water companies. The G.P.O. was represented by Mr. Hunter, solicitor. The London County Council were not represented, but had sent a memorandum to the committee. The Electric Lighting Companies were not represented.

MIDLAND RAILWAY ELECTRICIAN.

The hearing of evidence on behalf of the railway companies was resumed.

Mr. LANGDON, superintendent of the electrical department of the Midland Railway, examined by Mr. MOON: The block signals of the railway had been very seriously affected at Walsall to a distance of 3 miles 8 chains from where the electric tramway crossed the line. The current affected the instruments, and he thought it very possible that in the course of time the disturbance was likely to increase, when the signals would probably be affected at a yet greater distance. Leakage would probably increase as time went on, and other disturbing causes would arise. There were 32 towns on the line where power had been granted for electrical tramways. The only way of rendering railway working safe—and it was a very serious question—was to disassociate entirely these high currents from the earth. That was imperatively necessary without question. The primary question, as far as the railway was concerned, was, of course, that of the safety of the public, and if the railways protected themselves as far as they could by metallic return, it would not be sufficient for the safety of the public unless it were possible to ensure that the metallic circuit should always be in a perfect condition. If it were compulsory that the high currents should be insulated from the earth in the first instance, and then the railway service from the earth in the second instance—if anything went wrong with the high currents, there were two strings to the bow. Having regard to the danger which would arise from anything going wrong with the instruments, it was not safe to put all one's eggs in one basket. He thought the notion that a single return for a number of wires would be sufficient, altogether erroneous. He would much prefer to give each circuit its own independent return wire. The railway companies were not compelled to go to Parliament for powers, as they used their own property for the wires. The railway companies would foster electric traction. No one had a right to a monopoly of the earth. Telegraph, telephone, and railway companies had all used the earth, until they had been dispossessed by the heavy currents. These heavy currents would, of course, monopolise the earth.

Cross-examined by Mr. GRAHAM: The first thing he had to look to was the safe working of the block signals. It was a question of public safety.

Mr. GRAHAM: Do you know that the adoption of these clauses would have the effect of killing electric tramways?

The WITNESS: Well, it is a question of public safety. He had had experience of earth currents. They were not serious, because they were understood, and precautions were taken against their becoming dangerous. These earth currents were very exceptional. They only occurred probably when the aurora borealis was to be observed, and therefore at very long intervals. They affected the signals very much less than the currents from the tramways did.

By Mr. WALLACE: The cost of doing just what was necessary to guard against the tramways currents was £104, but a lot of the material was ready at hand, such as the poles, and this did not include wages. If electrical traction became general, he anticipated that one-third of the company's wires would be affected, and they would have to lay out about £17,000 or £18,000 to make them safe.

By the CHAIRMAN: Assuming that the tramways used an insulated return, he would still advise the railway company to put down a return.

By Mr. MOLLOY: The only absolute safety, as far as safety could be absolute, was to be found in the metallic circuit, both on the tramways and the railway, and if adopted only by one of those interests there would be only half the precaution. The real solution, was disassociation from the earth on both sides.

G.W.R. ENGINEER.

Mr. CHARLES ERNEST SPAGNOLETTI, M.I.C.E., Past President I.E.E., for 37 years chief electrical engineer to the Great Western Railway, examined by Mr. POPE, said the best system to ensure safety was an insulated conductor, both of the outgoing and of the return current of the tramways. For additional precaution, it would be desirable that the railway signals should be equally protected. The return wire for the railway company alone would not be sufficient, because if anything went wrong with it, interference would take place from the tramway currents.

By Mr. GRAHAM: Insulated return wires to the company's instruments would provide protection as long as the insulation lasted. The area of disturbance caused by the tramways was very large.

By Mr. WALLACE: The currents used for electric lighting were very similar to those used for traction. There had been a disturbance on the District Railway in October, which had affected the working of the whole of the signalling system between St. James's Park and Sloane Street. This was caused by an accidental leakage from the supply of the Westminster Electric Supply Corporation, and it was ultimately found that at the generating station an armature had short-circuited through the earth. There was the experience of the City and South London Railway, where, although the currents were high, there had been no absolute disturbing influences to any serious extent so as to affect the telephone company or the G.P.O., but in this case there was a large metallic surface formed by the tube which contained the railway, and which took the current back. Railways built on this principle were very well insulated, because the return circuit was not only by the rails, but by the tube. He would discriminate widely between an overhead system such as that at Liverpool

and an underground one like that in South London. He would have different restrictions for tramways on the surface, with a return circuit along lines which would be affected by damp and other causes.

By Major DARWIN: The disturbances referred to in the case of the Westminster Electric Supply Corporation extended over the line for 700 yards.

By Mr. BRUNNER: There were no serious disturbances from the South London Railway. With delicate instruments it could be discovered, but he did not think it was sufficient to ring a bell. In the case referred to by Mr. Preece, the pipes to which the wires were connected would of themselves set up a current. If the current of itself were sufficient to set a bell ringing we should consider it rather a serious disturbance.

THE TRACTION INTEREST.

Mr. JAMES SWINBURNE, M.C.I.E.E., M.C.P.S., author of various books and scientific papers, managing-director of Swinburne and Company, Limited, examined by Mr. GRAHAM, said the telephone was a very sensitive instrument. A small current did not interfere with it as much as a larger current, but with very much greater proportion than one would at first sight expect. If there was a disturbance which annoyed one in a telephone, and the size of the disturbance were reduced, the annoyance would not be reduced in the same proportion, though of course it would be reduced. He looked upon the single wire system in telephones as a cheap and bad system. Practically, all the interference to which telephones were liable, he attributed to the use of a single wire and the earth or water pipe return. It was not so easy to disturb the telegraph. The earth return was rarely used on telegraphs, which were used principally for communicating over long distances. As a matter of fact, nearly all telephones used the water pipes as returns. Earth plates were used where water pipes were not accessible. The use of the water pipes for a return made the telephones more sensitive to external currents. Both electric light and traction companies used currents as much larger than telegraph currents as the telegraph currents were than the telephone currents. The light companies, under the existing law, insulated their returns, because the law told them to do so, and because they could not use the earth return, because it was impossible to take large currents through the earth. They must use returns, and it was very little expense to insulate them, therefore they spread their returns over two sides. The light companies had to pay for and put down their own returns, and there was no reason, having done that, why they should not insulate both their go and return. In the case of the tramways, the conditions were different. There was either a complete return or a very fair portion of a complete return provided by the rails. There the conditions as to insulating means the same, because the rails could not be insulated. It was necessary to make contact with them from point to point. This therefore necessitated the use of bare conductors in the tramway, whereas it was not necessary in the case of the light, and that put the matter on a completely different basis. Tramways had a natural uninsulated return in the rails, and in that respect there was no analogy between the light company and the tramway company. In the former case the wire could be covered, but that could not be done with the tramway. It must be naked so that it could be got at. The light wire could be put in a culvert and covered over, but that was impossible with the tramway, because it must be left open for the collector to get at it. There was not so very much difficulty in insulating the second overhead conductor. If underground the points of insulation were exposed to damp, snow, dirt, and so on, which collected and made a bridge to the ground over which the current would pass. The difficulty arose from the open slot. The conductor must be exposed all along the line so that the collecting brushes might reach it, and it was exposed in the very worst position, and in an unget-at-able place. Even if the culvert is drained, damp could not be drained away, and the damp would cause great disturbance. It was impossible to really insulate the conductors, and that had been the difficulty in the United States. Without exception the single trolley system, such as that at Leeds, had been adopted there, and was rapidly displacing the horse and cable tramways. It was a good deal cheaper than the horse, and somewhat cheaper than the cable in working. It had been found to interfere with the telephones, and in the result the authorities had come to the conclusion that the roads were meant for traction and not for talking through. The double trolley system would be much more difficult as to insulation, but not so difficult as underground insulation. It was also very complicated, and there was great difficulty in managing the collection of a double current overhead. If it could be used at all it would only be in country districts. The practical system was the single trolley system, which had virtually ousted all other systems in the United States. It was used in Boston where they were proud of their streets, but would rather have it than go without it. He regarded the Buda-Pesth line as only the beginning of a system. It was but a few miles long, and was a simple case with few crossings and few turnouts. It was no example at all of what would be the case in a complicated urban system with underground culverts. The branch lines in underground culverts would cause enormous complications, and that was where $\frac{9}{10}$ths of the difficulty would come in, because all crossings had to be arranged in such a way that the tramway car could not make any short circuits. The only way the difficulty had been solved was by allowing a gap, and it was impossible to work such a system in a place like London. It was impossible to get enough momentum in the car to carry it 10 or 15 feet, and the only way was to get out and push. He thought the telephones and telegraphs would be perfectly protected by insulating their returns. The conditions of tramway working were such that one could never depend upon any system of insulation. It would not be practical, possibly, to make a tramway system so perfect that it would not disturb telephones with earth returns. No engineer would undertake to put up a tramline where he was liable to an injunction for leakage. There was a difficulty, too, from induction, and he thought induction, generally, the more important cause of disturbance. He had come to the conclusion in the case of the Leeds tramway that induction caused the greater disturbance. Induction depended upon the relative position of the conductors compared with the position of the telephone, and the position was set out by the exigencies of the case. Conductors must be put in a certain position; they could not be twisted to get over induction in the case of tramways. Insulation of the tramway would have nothing to do with the induction which took place with perfect insulation. He did not consider the expense of duplication on the part of the telephones would be great. It would not be necessary to double all the wires in the exchange. It would not be necessary to alter the switchboards. It would not be an expensive matter to protect railway signals. One wire would be sufficient for several signals. The telephone patents had expired, and there would probably soon be competing companies who would use metallic returns, which he thought would soon be used in most towns. Where the telephone was largely used metallic returns must be employed. It either meant the large electric interests must not develop, or that the telephones and railways must protect themselves—not necessarily by using return wires, but they must have some form of protection. He had investigated the disturbances to the telephone at Bournemouth. It was caused by electric lighting, and a hum could be heard. It was possible to talk through the disturbance, but it was annoying. The light company had insulated wires. Neither the telephone nor the electric lighting was large.

Cross-examined by Mr. PEMBER: A considerable uniform current did not hurt the telephone so much as the telegraph. Most of the return current from the telephone would go through the water pipes to which the circuit was attached. Insulating the second wire doubled the difficulty of detecting a breakdown. One might break down and not be detected, and another might break down in a different place, and the whole electric force would be sending an earth current from one place to the other, which would be a very much more serious thing. There was no great difficulty in insulating one conductor, the difficulty was in insulating another. The difficulty was also increased in the motor; it was necessary to take two wires down the plough instead of one. In a place like London, reference should be had not only to the systems at present in use, but also to those which might come forward in the next few years. A great many engineers had been working—not very successfully—at systems which had neither overhead wires nor culverts. The arrangement proposed was to have surface conductors, which were made alive by the car going over them, and directly it had passed, the current was disconnected. Such a system might be the only one that could be used in London, but it must be connected with the earth, on the surface of the ground. Therefore it was quite possible that in the future the only system available in London might be required to be connected with the earth at certain points. If that did not work, he should recommend the overhead system as the least objectionable. He would put in the overhead system wherever the people would stand it. It was a question of the alleged beauty of the streets against practical convenience. If a collector was placed at each end of the car, the gap difficulty might be got over, but there might be other difficulties. Induction might be got over by putting the two wires close together, but he did not think they could be put close enough to prevent telephone disturbances. It must be remembered that the water pipes run along the streets, and the telephones attached their wires to them, and that was the cause of the disturbances to the telephones. The telephone reading at Leeds was fairly good when undisturbed. Their communication with London was very good. When the telephone at Leeds was disturbed, it was considerably disturbed.

By Mr. POPE: If currents were allowed to go into the gas pipes, and the pipes were made the positive pole, they could eat away the pipes, but it was not necessary that the ground return should eat away the gas or water pipes—it was not likely, if the ground return was properly arranged.

By Mr. CRIPPS: With two overhead wires, there would always be the risk of short circuit. The safest way would be to have a ground return. If the gas pipes were made the negative pole, they would be quite safe. It was not quite realised, he thought, that if there was any electrolysis due to escaping currents, it was only a percentage that would take the gas pipes. In order to wear the gas pipes, it would be necessary to wear out a great many systems of rails. The electrolysis on the tramways plant would be very much more serious. Their own rails would have to be eaten up several times before they could eat up the gas pipes.

By LORD CLIFFORD: The gap difficulty might be got over by accumulators, but the difficulty would be very serious.

MR. R. E. CROMPTON.

Mr. R. E. CROMPTON, V.P.I.E.E., M.I.C.E., managing director of Crompton and Company, Limited, examined by Mr. GRAHAM, said the protective clauses had prevented electric traction from spreading. His firm, in common with others, had been asked by the Glasgow Corporation to take the responsibility of complying with the pro-protective clause in their provisional order, and had found themselves utterly unable to do so. It was the Plymouth clause. He spent a long time in trying to devise means to so arrange the plant that they should not affect the telephone lines, and his firm were reluctantly obliged to decline the responsibility. This was nine months ago. The result of his experience was that it was practically impossible to insulate electrical tramways in such a way as to make it quite certain not to interfere with the telephones. He considered double overhead conductors would be unsuitable. Single overhead conductors had been objected to by local authorities. The attempt to make a double overhead system would be a waste of time. He had been at work for four or five years endeavouring to perfect the underground

system of double conductors, and had invented devices and patents, but had not been able to introduce them into any complicated system of lines. The difficulty of dealing with two insulated conductors was so great as to be practically insurmountable in our present state of knowledge. The double insulated conductors meant a series of blanks, and the cars would be without propelling power at these blanks. Buda Pesth has a tramway system which had been constructed regardless of expense. It was a magnificent piece of work, but the difficulty of the blanks had not been attempted to be dealt with, and whenever two cars stopped shortly after each other, the second car had to be shouldered over the crossing. Of course when heavily loaded this led to delay. A slot system would probably be the system of the future, but not such as that at Buda-Pesth, on account of the width of the slot, which would admit a Hansom cab-wheel. But a narrow slot system could be arranged for a single insulated conductor, but the rails must be used as a return conductor, insulated as far as they could be insulated by the roadway itself. But he did not think the rails could possibly be insulated under all conditions, and if only part of them were insulated, they might leave off attempting to insulate the whole. It was not possible to so insulate them as to ensure not interfering with telephones. It was only a very microscopic quantity of the current that would go through the gas pipes. The question of electrolysis due to leakage had been enormously exaggerated. He had for years taken every means to ascertain whether such damage was being done as had been stated, and he had never yet traced a case to the electric current provided the precaution was taken of keeping the proper pole of the generating system to the earth. He had under his charge many miles of mains, and had never been able to detect any action so serious that it could be said that it was in excess of what happened before the time of electric lighting. It was the immunity from competition which enabled the telephone companies to use earth currents.

By Mr. PEMBER: The plan adopted on the Buda-Pesth line did not prevent dirt, &c., getting on the conductor and causing leakage.

FIFTH DAY.

The CHAIRMAN presided. The hearing of evidence on behalf of the traction interest was resumed.

Mr. CROMPTON, in answer to Mr. MOULTON, said, he objected to the Buda-Pesth system. The crossings were very complicated. There were places where the car was out of electric connection, and if it stopped it would have to be pushed over. The difficulty could be overcome by putting a double system of ploughs, but that was a complication to be avoided. Such a complication he did not think existed in connection with the City and South London Railway, but he could not say positively. The Buda-Pesth brakes were about 14 feet long and the cars 30 feet. If one plough was placed in front and one behind, a distance of more than 14 feet could be covered, but he thought the car would probably be twice as often out of contact as at present. Double collectors doubled the causes of trouble. On the Southend system, which he had put up, the single system was adopted, the rails being used for the return. To get over the difficulties of sparking, it was sometimes considered advisable to have two collectors, so that if one collector jumped at an insulated point the spark was avoided on account of the other being on the conductor. Extra complication was entailed even when the double were of the same potential, and they had not yet been found advantageous as had been expected. He had used them, but did better without them. He thought they had been taken off this year, and were not now being used.

By Mr. GRAHAM: One reason why he could not use the system which was now being adopted for the whole of his tramways was that as he understood the proposition it involved doubling the electric pressure, and that was a condition of things he did not think would be permitted by the Board of Trade, and therefore he and other engineers had never had it under serious contemplation. The conductors in a conduit were very much more difficult to insulate than others. It was not a case of doubling the difficulties, it was much more like increasing them four, five or ten-fold. To talk about the Buda-Pesth system being possible in England, was mere idle nonsense. It could not be adopted even if engineers wished it.

By Lord ROSSE: The Buda-Pesth system would really mean taking up the street to a depth of 45 feet and a width of 45 feet. The slot had to be kept open by the action of cast-iron frames of this size or it would close.

By Lord CLIFFORD: The leakage difficulty would be much greater here than in Buda-Pesth. This was a damper climate, and there would be much more falling of mud upon the conductors. The street traffic was much heavier and the particles of iron in the mud were in much larger quantities. Accumulators would get over the gaps, but their use would lead to great difficulty and expense, and an additional complication. The use of accumulators was a pretty idea which everybody hoped to see brought into practical working, but that had not come yet.

By Mr. MOLLOY: Without allowing some leakage it would be practically impossible to carry out a tramway system. In the case of electric lighting, he knew that the leakage had not done any harm. If the leakage was approximately the same from the tramway system, the same condition of things would prevail. So far as the injurious effect was concerned, it would be very little in either case. The electric light action was of no importance, if the right pole was brought to earth.

By Lord RUSSELL: He had not worked out the problem whether it would answer to have one overhead wire and one underground return, both insulated, sufficiently to see whether the difficulty one would meet with in carrying out details would be great; but apparently it would do away with the difficulties about gaps at crossings.

By Mr. FORWOOD: The castings in the Buda-Pesth culverts, which occurred at regular intervals, were 45 feet square. They practically formed a sleeper to the rail on one side. It might be possible to do without the 45 feet, if one conductor were placed on one side, and one on the other; but it would create great difficulties at the points. The cost of the Buda-Pesth line was £4,000 a mile. If they took such a place as King's Cross, where there were a great many lines, it was much more likely to cost £10,000 or £11,000 a mile. All the underground obstructions would have to be removed. A pipe was often found passing along the very track one wanted to occupy. This was only a probable estimate, because there were unforeseen contingencies which were sometimes unexpectedly heavy, and sometimes unexpectedly light. He should say £8,000 a mile would not be at all an extravagant figure for the cost in London—in all probability this was an under estimate.

By Sir BERNHARD SAMUELSON: He had seen a manhole opened at Buda-Pesth, and there was mud upon the conductor, although, to prevent it, the conductors were placed not perpendicularly under the slot.

MR. A. R. BENNETT.

Mr. A. R. BENNETT, who explained that he did not give evidence voluntarily, but because of an order of the House of Lords requiring his attendance, examined by Mr. CRIPPS, said he had been chief engineer to various telephone companies. The cost of a new exchange on the metallic circuit system, if designed from the beginning exclusively for metallic circuits, and without any intention of putting up single wires in the ordinary way, would not be appreciably more than that of a single wire exchange with ordinary wires. The adoption of the metallic system enabled the individual wires to be grouped closely together, without any interference with the efficiency of the service, so that the wires might be put into cables, and a great many might be contained in a small diameter. The open wires which had been used in an efficient single wire exchange, had to be strung up on supports, which had to be kept at a distance of not less than 8 or 9 inches apart, and preferably the distance would be 12 inches. Therefore the space occupied by the wires with a single wire exchange, was necessarily much greater than if the wires were put into a cable. It was possible to put the single wires into a cable for a short distance, but there were practical defects which were very seriously against it. Single wires in a cable were necessarily brought very close together, and the induction between wire and wire was very greatly augmented; so that except on very short lines, disturbance due to induction was very much greater than if the wires were strung separately overhead. He believed single wires were grouped in cables for short distances in some towns. The cable form would only be used with a double return system. The cable had the wires in a very much smaller space, and did not occupy much room on the roofs. A telephone exchange, designed expressly for a metallic system, required a very much smaller space and other fixtures than open wires. In dealing with underground wires, the metallic was the only practicable system. The metallic system had been introduced by the Mutual Telephone Company in Glasgow in February, 1891, and generally the subscribers were very well satisfied, and it grew very quickly. To alter the single system to the double would require very great care, but it could be done without interference with the switchboards, and so on. He would abandon all idea of exactly doubling the number of open wires, and should replace the open wires to a very large extent by cables containing metallic circuits, these cables preferably to be put underground, and if not, hung over the houses. The cables could be erected and not brought into use until the line was entirely complete, when they could replace an equal number of circuits on a single wire. That would entirely meet the difficulty of the currents from traction, and obviate disturbances to the telephone from every other source. Instead of doubling every single wire, it would be possible to use a few common return wires of high conductivity, which would replace the earth at the subscribers' stations, and also at the telephone exchange. It was true such a method would not be so complete a cure as entirely doubling the single wire system, but it would suffice. It would not be nearly so expensive, of course. The metallic circuit would provide a perfect system, and one could hear nothing at all on the telephone except the voice of the person speaking. The very natural result would be, that the demand for telephonic communication would increase. The most perfect protection for railway signals would consist in absolute duplication of the wires working from the signals, but the disturbance could also be prevented in two ways. In the first place a common return wire, or to avoid possible disturbance two separate return wires joined together, might be used for a considerable number of railway instruments. Another plan would be to run a wire back from the railway station or cabin where the disturbance appeared a certain distance, and there put it to earth. For instance, if block signals were proved to be disturbed at Euston Station by the action of electric lighting or tramway currents in the neighbourhood, a very efficient cure would be to run one, or preferably two wires, back to Chalk Farm, a mile or so out, and connect the railway signals to this common return. An earth plate placed at Chalk Farm would be, in his opinion, sufficiently removed from the influence of the tramway or light currents at Euston, while the provision of two separate earth wires would obviate all accidents through the breaking of one. From the traction point of view, he thought it would be very difficult to deal with the currents so as to insulate them if the telephone companies used the earth return. If the tramways were entirely separated from the public roads, the difficulty would not be nearly so great as when the tramway was in a public road subject to the influence of the ordinary traffic.

Cross-examined by Mr. PEMBER: He was now in the service of the New Telephone Company. It was not practically the National Telephone Company. The National held most of the shares—they did not hold all. He had taken out patents applying both to the earth and metallic systems. Naturally, he wanted to get his patents used.

By Mr. BRUNNER: His experience showed that the vibration

arising from cables, when properly fixed, was not in excess of the vibration arising from single wires. Vibration was not the trouble that it was formerly, as light wires were now used. He did not think a cable ever gave rise to complaints on that score.

MR. ALEXANDER SIEMENS.

Mr. ALEXANDER SIEMENS, examined by Mr. CRIPPS, said he was a director of Siemens and Company, Limited. Telephone exchanges had been put up with metallic returns, cables with twisted wires being used to get rid of induction. The exchanges in Australia on the single-wire system were giving trouble, and were being altered into the metallic system. As soon as telephones began to be multiplied in any particular place, it was found necessary, quite apart from the disturbance of extraneous currents, to use metallic returns. Block signals were mostly already guarded. It should not be forgotten that the disturbance created by the earth currents in these wires was very often much greater than that caused by any stray currents from electric railways, and, therefore, the block signals must be protected against these earth currents, and that protection would hold good against any other stray currents as well. Metallic circuits for telephones did not necessarily mean doubling all the wires, but if induction was to be got rid of as well, the wires should be doubled. The other method only protected against induction. In the Leeds case, the chief difficulty was from induction. He believed that for telephonic purposes underground wires would take the place of overhead wires, and then there must necessarily be a metallic circuit return. The Buda-Pesth system would be at least 50 per cent. more expensive here in England.

Cross-examined by Mr. WALLACE: The Buda-Pesth tramway worked perfectly. There were 60 motor cars running at present, and about 15 miles of tramway, and the line was being extended. He did not think there was any difficulty in the crossings.

By Sir BERNHARD SAMUELSON: The currents which would interfere with the telephones or block signals depended upon the difference of pressure between the points where the lines touched earth. The Buda-Pesth system was expensive. An ordinary tramway with overhead wires would cost about £4,000 a mile, whereas the Buda-Pesth system would cost £6,000, if not more. His firm had tried to introduce the Buda-Pesth system into Bradford, but found it absolutely impossible.

By LORD CLIFFORD: A large number of telephones with earth circuits in one place would affect each other. In the case of London, you could hear about six conversations on the telephone at one time.

By Mr. MOLLOY: With a metallic circuit there would be no disturbance.

Mr. J. H. GREATHEAD.

Mr. JAMES HENRY GREATHEAD, examined by Mr. GRAHAM, gave some statistics of the increase in passenger traffic in London. The London General Omnibus had carried about 41,000,000 passengers annually, and in 1864, when the first section of the Metropolitan Railway had been open about 18 months, it carried 11½ millions, and the General Omnibus Company 40½ millions. Every line of traffic had gone on increasing, and as soon as the Road Car Company came into competition with the Omnibus Company their traffic increased much faster than ever before. 490,000,000 of passengers were now carried annually, excluding altogether the traffic of the larger railway companies, which was out of all proportion to the increase of the population. It was notorious that the present facilities for getting people in and out of London were not sufficient. The largest development had been in the case of the tramways, he thought because they had increased their facilities as time went on. The tramways had carried 200,000,000 of passengers in 1891, and all these were doomed to travel at about 5 miles an hour. That was about the maximum that horses could go. If electricity could be introduced that speed would be increased by about 50 per cent. The rate would be about 7½ miles per hour. At no point did the City and South London Railway interfere with the telephones. Facilities for insulation in this case were very much greater than where the lines ran along the road. It was possible to place the rails which carried the return circuit upon timber sleepers, and so get fairly good insulation. Originally there had been gaps at the stations in the iron tunnels, but they had been bridged by putting wires across from one iron tunnel to the other.

Cross-examined by Mr. PEMBER: The railway was being worked under the Plymouth clause, which the company accepted voluntarily after the railway was constructed. He was engineer for the Waterloo and City line, and he had accepted the clause for that. He was also engineer for the Paddington and Clapham Junction line. Unfortunately they could not accept the clause for that. He had accepted it for the Central London line, and for the Hampstead and St. Pancras line. The clause did not bring despair into the hearts of the underground electric railway projectors.

By Mr. GRAHAM: The Central London Railway was to be 6 miles long. The estimated cost of bringing the electricity from the motor for the line was about £75,000, and if an absolutely insulated return must be provided it would involve first of all a return conductor costing about the same amount. Then the working expenses of the generating power would be increased 15 per cent., and altogether it would result in an increased cost to the company of £40,000 a mile, or £240,000 for the entire system. What would be gained by this expenditure would be very trifling indeed. The return currents on the City and South London were very low in pressure. The total difference from one end to the other was only about 4 volts, and the maximum pressure between the earth and the rail was only 1¼ volts, so that there was very little chance of any disturbance or any action on the pipes outside the line.

Mr. PEMBER: On the Clapham Junction and Paddington line, did not you offer to metallically loop your line outside?

Mr. GREATHEAD said the line passed by the scientific institutions at South Kensington, where there were some extremely delicate instruments. On that account it was suggested that there should be an insulated return, and the company was willing to make it. Even then the professors objected to the line being brought there, because they thought there would be induction. The capital per mile was about £300,000. The distance was 4½ miles. The total first-class fare they would have demanded would have been 3d., and second class, 2d.

By Mr. MOLLOY: In the case of the City and South London Railway, there was no absolutely insulated return current, but there was approximate insulation. The telephone company did not complain. Mr. Preece had visited the line, and thought there was more disturbance than he liked, and certain alterations were carried out, and he was satisfied. There might be some induction, but not sufficient to affect the telephones.

By Mr. BRUNNER: He did not think Mr. Preece had complained since these alterations. He had visited the shop spoken of by Mr. Preece in his evidence. Between the gas and the water pipes there was a tension of about $\frac{1}{10}$th of a volt. It was barely sufficient to ring a delicate bell. He had also tested between the gas and water pipes at the various stations on the railway, and was unable to detect any difference of tension.

By the CHAIRMAN: The Liverpool overhead railway was not completely insulated. The rails were laid on longitudinal sleepers. There had been no complaints of disturbances The cost per mile was £85,000. The signals upon it worked automatically by electricity upon a current of their own, and were not interfered with by the traction current.

MR. F. J. PARSONS.

Mr. FREDERICK JENNINGS PARSONS, examined by Mr. CRIPPS, said he was chief engineer to the Thomson-Houston International Electric Company in Paris. He was experienced in the construction of electric traction on the Continent and in America, whence he had just returned. In Cincinnati, they had the double overhead system, which was satisfactory as far as it went, but it cost very much more to instal and keep it up, and all extensions which had been made were made with a single line. His company had constructed, approximately, 5,000 miles in America on the single overhead system. The earth return by the rails and the central conductor was practically universal in America. The suits between telephone companies and electric traction companies in the United States had always been won by the latter. In large cities, the telephone companies had duplicated their wires, and in small towns they had used a single return wire for a group of wires. The effect of electrolytic action was being felt, and it was being remedied by putting down a much heavier return wire. In the City of Boston was one of the largest electric tramway systems in the world. Electric action had been produced, and they were now putting down a wire of 18 millimetres in diameter.

By Mr. FORWOOD: Boston was a very awkward town to deal with. The streets were narrow, tortuous, and hilly, and the cars were unusually large, longer than anything he had ever seen on the Continent. They always had had a metallic return wire between the rails, the current propelling the car being overhead. There had been no accident from the overhead wires breaking. There were always kept ready the means of repairing a break in a few minutes.

MR. N. S. SELLON.

Mr. N. S. SELLON, examined by Mr. GRAHAM, said, he was a tramway engineer, and was connected with the Thomson-Houston Company, of America. The company had tried to do a large business with traction in England. They had had to refuse to enter into extended negociations with the Yarmouth Tramways Corporation, because they had the Plymouth clause in their provisional order. It was not practically possible to insulate the conductors in tramways, so as not to interfere with telephones where the lines were not underground, except at very great cost. In 1865, in the United States, there were only three roads working electrically, with a mileage of fifteen miles. There were now 500 roads.

Cross-examined by Mr. PEMBER: He had not constructed any electric tramways in England, except that of Leeds.

By Mr. WORSLEY TAYLOR: Electricity would reduce the present cost of traction. The average cost of horse traction was about 8d. per car mile, electric traction was about 5½d. or 6d. Steam traction was objected to by local authorities, and was fast dying out. It was absolutely necessary in the future to have some system that would supply the place of steam. In the case of heavy gradients there must be some sort of mechanical power. By the use of electric traction a better and more regular service would be got than by steam or by horses. Since the introduction of electric traction in Leeds, the percentage of traffic was something like 47 per cent. more than was originally carried on by horse traffic. Better cars were used, and they were more cleanly and were lighted by electricity.

MAJOR-GENERAL WEBBER.

Major-General WEBBER, R.E., examined by Mr. CRIPPS, said, he was engineer to the Postal Telegraph Company. In several campaigns he had been director of the army telegraphs. He had been managing director of the Bell Telephone Company, and had held other appointments. A mechanical return of telephones was indispensable to a good service. Wherever the number of conductors exceeded seven or eight, he would for economy's sake, place the lines underground, if less, he would have them overhead. If underground, they were bound to have a metallic return. In the case of the Clapham Junction and Paddington line, the instrument used by Professor Ayrton was a magnetometer, which was more sensitive to magnetic disturbances than a microphone. In that case it was obligatory upon them to provide metallic returns. In the case of lines overhead with 7 or 8 conductors, one strong metallic return would be sufficient. Therefore the duplication of their lines was entirely confined to

the small branch lines which lead to the houses of subscribers, the average length of which might be taken at $\frac{1}{10}$th of a mile. Therefore they would only have to duplicate $\frac{1}{10}$th of their system in London, which would reduce the outlay to far less than it had been put at by their engineer. It would mean about 12s. worth of copper wire per mile to each conductor.

THE MUNICIPAL CORPORATIONS.

Mr. HESKETT, electrical engineer to the Blackpool Corporation, was examined by Mr. WORSLEY TAYLOR on behalf of the Municipal Corporations. He said all the main streets at Blackpool had been taken up during the last month, and he had seen no evidence of electrolytic action. At the request of the Board of Trade they had earthed the negative terminal of the dynamo to the rails, and also to the water mains, so as to prevent any possible electrolytic action. He had never found any interference to the telephones from their tramway, nothing to make conversation difficult. They were about to alter the conduit which contained the conductor, and to make it so that it was only open as the tram passed. This was to avoid any trouble from water and dirt. They would use the centre conduit as a return, and also the auxiliary copper conductor. The difference of potential was within 1 and 1½ volt. It was most unnecessary that tramways should be required to use insulated returns; the difficulties in the crossings and turnouts would be very great. The telephones at Blackpool had no metallic return, and the Corporation had had to take away their local exchange and put down their own on the double wire system. The tramway carried over a million passengers last year, and on the part of the Corporation he deprecated any obstructive clauses.

By Mr. POPE: They were promoting a provisional order to extend the line. The greater portion of the new section they were leasing to be worked by accumulators. They were accepting from the railway company a clause which bound them to construct and work so as not to interfere with their signals. They would not have accepted the clause had they not had some voice in the way the company were to make alterations in their system. The railway company's alterations were, to a certain extent, to be paid for by the Corporation.

By Mr. PEMBER: He believed the Corporation accepted the Plymouth clause in the provisional order.

TOWN CLERK OF WALSALL.

M. J. B. COOPER, Town Clerk of Walsall, examined by Mr. MOULTON, said the use of steam on the tramways had been found most objectionable owing to the noise, effluvia from the coke and steam discharged, and the Corporation had been obliged to substitute electricity, with highly satisfactory results, and a great increase of traffic 95,000 passengers had been carried in 5 months. If they had to choose between doing away with the tramways and the telephones, the telephones must go. There was a certain amount of roaring on the telephones, but not enough to cause inconvenience.

Mr. YOUNG, general manager of the Glasgow Corporation Tramways, in answer to Mr. WORSLEY TAYLOR, said the tramways were a fraction over 30 miles long, and cost £345,000. They had the Plymouth clause. In September last tenders were asked for applying electric traction, and the persons tendering were to be responsible for any damage occurring under the clause. The Corporation received 11 offers, but none of the firms tendering would accept the responsibility of that clause.

Mr. JOHN WARD, Mayor of Leeds, examined by Mr. MOULTON, said the Corporation had a little over 22 miles of tramway worked by steam and horse-power by the Leeds Tramway Company. A little over three miles was worked by electric traction on the Thomson-Houston system. The Corporation had withdrawn the power to use electricity out of their Bill because of the Plymouth clause. Their experience of electric traction was satisfactory, and no portion of the tramway had been so popular as the portion so worked. The Corporation was in favour of electric traction, and thought there should be no clause to prevent it.

Mr. KEENLEY, Mayor of Salford, examined by Mr. WORSLEY TAYLOR, said the Corporation had 13 miles of tramway coupled up with the system of Manchester, so as to form a continuous system. The town could not do without the tramways. A Bill had been introduced for the purpose of doubling a portion of the line, and the telephone company had opposed it, and had asked that their clause should apply to the whole system. The telephone company wanted retrospective powers applying to the old portion of the line, although the Corporation had electric powers for it. The Corporation withdrew the Bill, but they meant to bring it forward again.

Mr. JAS. L. SOTHERN, member of the Manchester Town Council, examined by Mr. BALFOUR BROWNE, expressed himself in favour of the Corporation's acquiring power over the telephones.

SIXTH DAY.

At the commencement of the sitting, representations were made on behalf of Nottingham and Liverpool respectively, to the effect that though the corporations of these towns agreed to a great extent with the evidence that had been put forward by the other municipalities, yet there were some parts with which they did not agree, and they thought it right to make this protest.

BOARD OF TRADE ELECTRICIAN.

Major CARDEW, electrical adviser to the Board of Trade, examined by the CHAIRMAN, said that Sir Courtenay Boyle had requested him to give evidence with regard to the accident at Preston. The accident had been attributed to electrolytic action, but that was, in his opinion, not the case. He attributed the accident to heat, caused by the passage of an electric current between the iron culvert in which the electric mains were contained, and the gas service pipes, which were underground. He produced specimens of the pipe, one of which showed a hole where it had been in contact with the culvert. A second had been melted, and he attributed this to the electric arc set up in the first place by electric contact between the culvert which was charged and the gas service pipe, and as the gas pipe melted away an arc was established, which caused the amount of fusion which was apparent. It was due to an imperfect state of the circuits of the company, the Preston Electric Light Company. One side of their circuits had a temporary connection with the earth which was accidentally formed. The other side of their circuits was accidentally brought into connection with the culvert which enclosed the wire. The third specimen was taken from a service pipe, from which 3 inches had been melted, where it came into contact with the Electric Light Company's culvert. In a fourth case a large piece was melted out of one of the service pipes which touched the culvert. He attributed it to something quicker than any electrolytic action—to heat produced by the action of the current. The conductor not offering sufficient conductivity in section heat must be produced, and the melting took place. The dry and sandy soil of Preston had, he thought, something to do with the accident.

By LORD RUSSELL: If the system had been carried out exactly as to details by the contractors, and if all reasonable care had been taken and proper tests made, he was certain the accident would not have happened. Such a form of culvert containing conductors, and nearly in contact with bare unprotected gas pipes, was an error of judgment. It was probably due to the somewhat hurried way in which the installation was carried out.

By Mr. MOLLOY: The electric light conductors were strips of copper within an iron culvert. The iron culvert was, roughly, a half cylinder with a flat top, and the electric light strips being held on insulators, were separated from the culvert by some two or three inches everywhere. But the connection was not made from any contact between the strips and the culvert, but it was due to the arrangements made for switching in some lamps which had been placed for the public lighting of the Square, and by means of the conductors to these and the switches the electric light conductor was brought into connection with the culvert, and thereby the current escaped through the gas pipe.

By Sir BERNHARD SAMUELSON: Several cases had occurred of damage to water pipes, and his attention had been drawn to a case of damage to a gas meter. From tests which he had carried out on an occasion on which a water pipe failed he was enabled to prove that the damage was caused by the mains of the electric lighting company, and that it was electrolytic. With regard to the question of metallic action between the negative terminal of the dynamo and the water main in the case of tramways, in the case of the Leeds tramway, and in one or two others, that connection had been made at his suggestion. It had never been subject to any regulation of the Board of Trade, for one reason, they were not empowered to make regulations respecting water companies. He considered it most essential that the tramway company should take every precaution to prevent injury to these pipes, and he had suggested to them that a good plan would be to connect the negative terminal of their dynamo to the water main, the result being to raise the whole electric current potential positive with regard to the water main and the earth. When that was the case any current passing between the electric system, including the rails and water pipes, would tend to corrode the rails and preserve the water pipes. This connection was made a year and a half ago, but he had never felt absolutely satisfied and certain in his own mind. Just a year ago he had gone to Leeds to examine the result, and he discovered that the potential electricity of the rails was, as he had anticipated, everywhere positive to the water pipes, and amounted to about 2 volts at the extreme end, and he could not find any sign of injury, though the roads were opened in many places, to the gas and water pipes. The connection should be so arranged that it should be open to inspection.

By LORD RUSSELL: In the case of a tramway working with an uninsulated return, precautions must be taken that the leakage should not hurt other people. Leakage could not be prevented, but the damage could be confined to the tramway's conductors, and other people's property could be preserved.

By the CHAIRMAN: The main object of the clause forbidding earth connection with houses was the protection of the consumers into whose houses the electricity was to be brought. The Board of Trade had been advised that an earth current should not under ordinary conditions, with the conductors that were generally used, be taken inside houses. But, on the other hand, it was felt that there were certain conditions, particularly where the current was not to be brought into houses, but to be taken to sub-stations belonging to the electric light company, where it might be desirable, even, in the interests of safety to have earth connection, and therefore the order was worded so as to admit, with the approval of the Board of Trade and the concurrence of the Postmaster-General, that earth connection should be made. He had suggested to the engineer of the City and South London Railway that he should make experiments to ascertain the exact facts with regard to the leakage at the shop in the Clapham Road, to which Mr. Preece had referred. The engineer had carried out certain tests in order to ascertain what the leakage amounted to, and how it could be prevented. The main result was to show a maximum difference of potential between their system and the gas and water pipes of 2½ volts, except at one station, where there was a difference of potential of about 4 volts between the gas pipes and the negative terminal of the railway company's system. He entirely agreed with certain answers given by Lord Kelvin, that, in his opinion, great improvements could certainly be made, and that very probably interference with other currents, even in the existing systems of working, could be practically avoided. It was impossible absolutely to avoid interference between any two circuits, but practical interference was another thing. Two days' testing on the South London Railway had already given much information as to where their leakage

occurred. He had no doubt that leakage could be enormously diminished in the case of such railways, and there could be no reasonable doubt that all practical interference could be avoided. First of all, the whole conductivity of the return rails must be utilised. That was not done to any complete extent at present. The conductivity was broken where the rails joined, and there it should be made complete. A decent amount of insulation should also be provided between the rails and the iron tube by using sleepers, such as teak. The South London Railway's sleepers were not creosoted, and certainly were more conductive of electricity than they ought to be. In the case of tramways there were greater difficulties, but there again what was to be aimed at was to take advantage of the whole conductivity and increase it by additional conductors on the return circuit or rails, and to adopt as far as possible the system which was used in the case of electric supply to maintain a uniform pressure throughout the whole district. In the case of electric supply the Board of Trade regulations only allowed a variation from the declared pressure of 3 per cent. With regard to disturbance, a constant unvarying current would not affect telephones in the least, however much was escaping to earth, but in the case of a tramway the current was always varying. The sudden variations were what, in his opinion, caused the greatest disturbance. A great deal of the variation was caused by sparking of tract or brushes, and by vibration of motor, and the way in which the armature of the motor was wound. He attributed the greatest importance to the system of testing the line.

By Mr. BRUNNER: He should expect the company to make their own tests—the Board of Trade could not undertake to provide everything. Up to the present the efforts of most electric companies had very naturally been directed to the system from which they got a money return, and testing was no part of that system. He did not think there would be any unwillingness on their part to make the tests and record them. They should be bound to produce the record of the tests when called upon.

By Mr. MOLLOY: Electrolytic action could be avoided with ordinary care, and no danger was to be anticipated by reason of a large extension of electric traction if proper precautions were taken. The regulations could be drawn so as to secure this.

By Lord CLIFFORD: Interference with telephones was due to a rapidly alternating current, and what would cure one would cure the other. As soon as serious attention was given to the matter he thought the tramways could get over the difficulty without resorting to an absolutely insulated system.

By Major DARWIN: At Leeds the Board of Trade had seen fit to increase the voltage from 300 to 500 under certain restrictions.

By the CHAIRMAN, at the request of Mr. POPE: He thought the number of telephone wires overhead had about reached their limit. He would rather not connect the negative pole of the dynamo with the gas pipes—it was a thing not to be altogether recommended. He would confine the connection to the water pipes. If the connections were made to water mains of large section the potential of the system was practically established throughout constantly; that was the lowest point; that was the potential of the earth. What was wanted was to make that the lowest earth, then the gas pipes would be protected as well as the water pipes. It would be necessary to carefully watch the action because it was just at the point where that connection was made, that any danger that might result would be shown. It was conceivable that a difference of potential might be produced between the gas pipes and water pipes, and then there would be a rise of electrical action between them; but that might be avoided.

THE GAS AND WATER INTEREST.

Sir FREDERICK BRAMWELL, examined by Mr. POPE, said he regarded electrolytic action as a real danger when a certain condition of things prevailed in regard to an enterprise such as electric lighting or tramways, where there was no proper insulation of the electricity from the earth. In the case of electric lighting, so far as he knew, that was never the case except by accident, but in the case of electric tramways, taking the Leeds tramway as a type, that was the case, and that condition of things he regarded as a real danger. He presumed that Major Cardew's proposition did not take account of the fact that it was necessary to have continuous water pipes. Gas pipes might be left unprotected, and the proposition did not take account of the fact that the water pipes had joints of such a character that they were absolutely impermeable by electricity. He should like much more experience with both gas and water pipes before he could say it would remove anxiety. The proper insulation both of the outgoing and incoming conductor was the only safeguard from electrolytic action, so that there should be no leakage whatever. The leakage by accident was very different from the harm done by interference with the telephone. The waste of the pipes by electrolytic action was due to the amount of current, and the time the electrolytic action continued. In the case of the telephone the annoyance was immediate, in the case of a gas pipe it was dependent upon the time during which it continued, and therefore a system which, as a rule, prevented any leakage at all, but which occasionally by means of imperfection allowed leakage, would still be effective. He did not regard such a provision as prohibitory of electric traction. He could not assume that the legislature would ever allow such a system as that at Leeds in the streets of London. If that was so, there was no other mode, except that of accumulators, by which traction could be had but by conveying the electricity at the bottom inside a tube underground, with a slot through which the connection could be made. There was nothing of an onerous or impracticable character in this. As a proof, he instanced the case of rope tramways, in which connection was made by an arm passing through the slot, and which in the case of electricity could be very much lighter. The legislature must either be prepared to allow a structure of this kind, or else overhead wires. If the electricity was to be taken in an underground tube, then the two conductors followed as a matter of course.

By Mr. GRAHAM: Water pipes filled with water were better conductors than gas pipes. With regard to Major Cardew's system, the joints of pipes were not electrical conductors. If they were good conductors there would be a neutralising of the harmful action, but it was purely speculative.

DR. JOHN HOPKINSON.

Dr. JOHN HOPKINSON, examined by Mr. GRAHAM, said that with regard to gas and water pipes there would probably be a certain amount of oxidation of the pipes from the currents leaking from the return rails. The only thing which in his opinion could be done to protect the pipes from oxidation was to insulate the whole system of electrical conductors as used in the tramways. If that system were adopted, arrangements for the testing the rails of a very simple kind could be adopted. He considered the danger to gas pipes was of a serious character. He could not agree that there would be any material protection by connecting the negative pole with the dynamo. By the aid of a diagram he pointed out how in his opinion it would cause oxidation of the gas pipe. In the case of a defective joint also the current would leap over the defect, and at the point at which it returned there would be oxidation. The only remedy was effective insulation. He agreed with Sir Frederick Bramwell's evidence.

Cross-examined by Mr. BALFOUR BROWNE: In country towns the gas and water and tramways in many instances belonged to the corporation.

By Mr. CRIPPS: The electrolytic action which had been referred to was the result of a fault which ought to have been put a stop to long before it had done serious harm.

PROFESSOR DEWAR.

Professor DEWAR, examined by Mr. POPE, spoke of the danger of electrolysis. He thought something might be done by connecting with the negative pole the water and gas mains. He referred to an article which stated that it had been dismissed as impracticable in the United States unless the connection was made with the gas mains. The proper course would be, undoubtedly, to have much more perfect insulation. The suggestion of connecting the negative pole was Sir Humphry Davy's plan of preventing the destruction of copper on ship's bottoms by putting a small piece of zinc at every 50 or 100 square feet and transferring the attack to the zinc instead of the copper by maintaining a small difference of potential. Unfortunately for the navy, that acted admirably in the laboratory, but not in practice. He would not rely upon the connection of the water to the negative pole. The principle of keeping a large metallic system practically connected with the negative pole would mean the transforming it into the condition of a metal which would not be attackable owing to the infinitesimal layer of hydrogen with which it was covered. But by the action of the salt the hydrates were reduced and the thin layer of hydrogen removed. Absolute insulation of the return current was the only remedy.

By Mr. BRUNNER: Upon such a gigantic system as a tramway, there must be a large loss of current and there would be great difficulty in testing for leakage. Variations in the current could be recorded automatically, but where to find the defect would be the difficulty.

GAS LIGHT AND COKE COMPANY.

Mr. FOULGER, chief distributing engineer of the Gas-Light and Coke Company, said the company had nearly 2,000 miles of mains without considering the small service pipes, and eleven stations in London where they manufactured gas. They had great difficulty in coping with escapes, especially beneath the hermetically sealed roadways of many parts. The concrete formed an arch across the road and the friable earth beneath was always sinking, leaving large holes in which gas accumulated. He viewed the connection which had been spoken of very seriously. In London, the interest of the water mains and of the gas mains were close together. London streets were full of various underground works, hydraulic mains, hydrants, electric wire tubes, water mains, sewer pipes and underground railways. The Strand was so taken up, that the Electric Light Company had had to hollow out the kerbways to lay their wires.

Cross-examined by Mr. BALFOUR BROWNE: Leakage accounted for considerably less than 1 per cent. of the gas made by the company.

By Lord LOTHIAN: The company had not yet had any cases where gas pipes had been corroded by electricity, but their pipes were all buried, and it was difficult to inspect them. He considered the danger a very real one.

By Mr. MOLLOY: He had no means of saying whether there had been any danger since the establishment of the electric light. He did not know whether the company had suffered from electrolytic action.

ACCUMULATORS.

Mr. L. EPSTEIN, managing director of the Epstein Accumulator Company, examined by Mr. POPE, said his firm had been supplying electricity for the Birmingham Central Tramway since August. There were six cars running regularly, and sometimes seven. Two sets of accumulators were used, as one charge could not possibly last for the 15 or 16 hours of service. The gradient of the line was in one part 1 in 25. Twelve sets of accumulators had been used since December. The weight of the accumulators was about two tons per car. Batteries for a car cost, in round figures, £500. The cars had run 80,000 miles since August, and of the 10,000 plates forming the batteries, not one had been renewed.

Cross-examined by Mr. BALFOUR BROWNE: He was the patentee of the system. The accumulators were in the first instance bought and paid for by the Central Birmingham Company, and the Accumulator Company maintained them at a rate of 1½d. per mile run. If his company were to renew the batteries to-morrow, it would cost the Accumulator Company, by the mileage the cars had made, three farthings, and they would get a profit of ¾d. The road was three miles long. The cars made an average speed of six miles an hour,

but ran up to 7½ miles per hour. The batteries supplied in August had had to be renewed, but not those supplied in December.

THE ASTRONOMER ROYAL.

Mr. CHRISTIE, Astronomer Royal, examined by the CHAIRMAN, said the instruments at Greenwich Observatory had been disturbed by the South London Railway. The Observatory was about five miles distant. Two circuits of wires had been established for the purpose of recording electric currents through the earth. The nearest earth plate to the railway was 2½ miles from it. The other corresponding with that circuit was at a distance of 5 miles. On the other circuit the line was nearly parallel to the railway at a distance of 4½ miles, and 400 feet from the bank of the Thames. The electric currents were registered by means of a delicate galvanometer photographically on a sheet of paper. The disturbances corresponded with the hours when the trains were running. They ranged from one-third to one-half of a volt in difference of potential between the two earth plates. Some alterations in the railway had reduced the disturbance, but it had since risen.

By LORD LOTHIAN: A very small amount of energy would make a large disturbance in the instruments.

By Mr. BRUNNER: The object of the observations was completely defeated by the railway. The matter was hardly so important that the committee ought to put expensive conditions on the railway.

This concluded the evidence.

SEVENTH DAY.

The final public sitting of the Committee took place on Tuesday, when counsel addressed the Committee on behalf of the various bodies.

LEGAL.

BIRMINGHAM TELEGRAPH COMPANY, LIMITED.

THE application by a creditor for the compulsory winding-up of the Birmingham Telegraph Factory Company, Limited, was again brought before the Birmingham County Court last week. A resolution for the voluntary winding-up of the company has already been passed. Mr. Parfitt (instructed by Mr. Hewlett, London) appeared in support of the application, which was opposed by Mr. H. Young (instructed by Dr. Rogers) on behalf of the liquidator (Mr. J. Rhodes). The application was before the Court on May 11th, and after a long hearing, the case was adjourned, in order that affidavits might be filed and certain witnesses cross-examined. The object of the adjournment was to enable enquiry to be made into the allotment of 3,000 shares in the Telegraph Factory Company to six directors of Fowler Lancaster & Co., it was alleged, as nominees of the latter firm. In the books of the company these shares were described as fully paid up, and the contention of the creditor who made this application was that they had not been paid for, and that the directors to whom the shares had been allotted were personally liable to contribute the price of the shares to the company's estate for the benefit of the creditors. Yesterday a joint affidavit by Mr. Fowler and Mr. Lancaster was read by Mr. Hugo Young, and Mr. Parfitt cross-examined Mr. Fowler upon it. It appeared that the telegraph factory was started by Messrs. Fowler and Lancaster, in conjunction with Mr. Slater Lewis. Messrs. Fowler and Lancaster transferred a portion of their business to the new company, together with contracts they had for such work as the telegraph factory was established to perform. They also from time to time gave out work to the factory, lent money for wages, and financed the factory. Mr. Lewis suddenly severed his connection with the factory, and afterwards in November, 1871, it was found that the factory owed Fowler, Lancaster & Co. over £6,000. Mr. Fowler and Mr. Lancaster were the only directors of the factory left after the retirement of Mr. Lewis, and they arranged with the directors of Fowler, Lancaster & Co. to extinguish the debt of £6,000, by a debenture of £3,000, and shares to the amount of £3,000. These £3,000 of shares were allotted as fully paid up to the six gentlemen referred to as the trustees for Fowler & Co.

Mr. YOUNG contended that the shares were given as a set-off, and were therefore paid for, and quoted a communication in which it was stated that the price of the shares was to be credited to the loan account.

Mr. PARFITT argued that the trustees were personally liable to pay for the shares, and thus be made contributors to the estate of the Telegraph Factory Company. They would have their remedy against Fowler, Lancaster & Co. There was no registered agreement, and he contended that there had been no payment within Section 25 of the Public Companies' Act. He did not deny that the arrangement was *bonâ fide*, but legally the shares were not paid for.

Mr. YOUNG said that the six gentlemen in question never held the shares, and had no interest in them. He was willing to bring an action against any one of them for costs if Mr. Parfitt's client would indemnify the liquidator against the costs.

Mr. PARFITT declined the offer.

His HONOUR reserved his decision.

DART *v.* ELECTRICITY SUPPLY CORPORATION.

IN the Queen's Bench Division, London, on Monday, this case came before Mr. Justice Cave and a jury. The plaintiff, Mr. Wm. Dart, who carries on business as a chemist at Southampton Street, Strand, claimed damages for injury to his premises and to his health by the vibration caused by the working of defendants electrical machinery The defendants denied that the plaintiff had suffered damage by their machinery.

Mr. W. Willis, Q.C., and Mr. Ellis were counsel for the plaintiff; Mr. Fletcher Moulton, Q.C., and Mr. Turrell appeared for the defendant company.

At the outset Mr. Turrell suggested that the jury should view the premises.

Mr. JUSTICE CAVE said the defendants ought to have applied for a jury view before. He could not stop the case now.

Mr. WILLIS, in opening the case for the plaintiff, was not surprised that the defendants should now want the jury to view the premises. The vibration of which the plaintiff complained had been different at different times, and the action could not be determined by a visit at the present time. The evidence would show that in November, 1892, the vibration was sufficient to justify the plaintiff in bringing an action. If the defendants had made arrangements by which they could carry on their business without causing vibration to the plaintiff's house, then an injunction could do them no harm. The plaintiff had carried on his business of chemist at Southampton Street for 30 years, and it was important that he should keep these premises. The house belonged to the Duke of Bedford, and the rent was £90 per annum. The plaintiff had a good connection from the hotels in the neighbourhood of Covent Garden. Prior to November, 1892, the vibration caused by the machinery of defendants interfered with plaintiff's enjoyment of his premises. The plaintiff's lease expired about 1891 or 1892, and he had an arrangement for a new lease from the Duke of Bedford of these premises; but before spending a lot of money on a new building, the plaintiff wanted to ascertain what it would cost to prevent vibration. The annoyance of which plaintiff complained was greatest from nine in the evening to one in the morning. As the business of the defendant company increased, they changed their name. The business was first of all started by Messrs. Gatti, refreshment contractors, and in 1888 these gentlemen put in new machinery for generating and distributing electric light. At that time there might have been two electrical engines, and perhaps two boilers, but certainly the machinery for distributing electricity was very small. The company was then called the Electricity Supply Corporation, Limited, but it was subsequently styled the Charing Cross and Strand Electricity Supply Corporation, Limited. In August, 1891, great alterations were made. The defendants began to excavate below the ground floor of their premises where the electric machines were placed. They went down 22 feet below the ground floor, and there were now four large boilers in this basement. The ground floor rested on iron columns, and on this ground floor, which was like the lid of a box, or the end of a drum, had been placed 8 or 10 very powerful engines. The plaintiff's premises were about 70 yards from the defendants' premises. A large portion of the property in the immediate neighbourhood Messrs. Gatti had been obliged to buy or deal with, and the neighbours who had arranged with Messrs. Gatti did not desire to give evidence for the plaintiff. The vibration had prevented Mr. Dart getting sleep, and he had got into a very nervous state. The upper part of his house he let off for offices, and in consequence of the nuisance some of his tenants had left.

Mr. DART then gave evidence substantially bearing out his counsel's statement. He added that his tenants upstairs complained that they could not do their writing in the premises, and left the premises in consequence of the vibration. In cross-examination the witness admitted that the house was now supported by struts, but he denied that the whole of the house was in a dirty, dilapidated, and rotten state.

Dr. JOHN GEORGE VINE gave evidence that he attributed the plaintiff's ill-health to irritation of the nerves caused by the vibration, and unless the annoyance was stopped the result would be disastrous to the plaintiff.

Mr. E. DE SEGUNDO, civil, electrical, and mechanical engineer (Associate of each Institute), practising as a consulting engineer at Victoria Street, Westminster, and until four years ago assistant manager of the Metropolitan Electric Supply Company, stated the result of experiments he had made on the premises of the plaintiff to ascertain the vibration. By placing mercury in a large saucer and by other tests, he found at times 38 distinct pulsations per minute. On defendant's premises there were 5 Willans I.I. engines, equal to about 200 H.P., and two or three smaller ones.

The case was not concluded on Monday when the Court adjourned.

On Tuesday morning further evidence was called to support plaintiff's case.

Former tenants of the plaintiff and his assistants stated that the vibration caused them considerable annoyance, and that they left the premises in consequence.

Mr. P. P. KIPPING tested the vibrations with microphone and telephone receivers.

Miss BRAHAM and Miss GREEN, typewriters and assistants to a firm of shorthand writers on these premises, said the vibration made them ill, and they could not work.

The Rev. Mr. LOWNDES, Vicar of St. Magdalenes, and a Mr. CHANNING, also testified to the existence of the vibrations at plaintiff's house.

In opening the case for the defendant company, Mr. TURRELL maintained that whatever vibration was experienced on plaintiff's premises was due to the traffic of the street acting upon a very old and shaky structure, and to the working of the printing machines at *Tit Bits* office.

Dr. JOHN HOPKINSON, F.R.S., Past President of the Institute of Electrical Engineers, said the defendants had asked him to go to the plaintiff's house to ascertain how much vibration there was. He had made several visits. By watching the surface of a cup of mercury, he found there was a slight vibration in some of the rooms. There

was increased vibration in the front rooms when traffic passed in the street. He did not notice any vibration attributable to the defendants' machinery. Some of the fainter vibrations he was not able to identify. The heavier vibrations were due either to people walking in the rooms, or to passing vehicles in the street. What he noticed ought not to interfere with the occupation of the house. Cross-examined: On no occasion did he find any abnormal vibration. He did not know that the defendant company had settled with Messrs. Anstice for £22,000.

Mr. SPENCER CHADWICK, chairman of the defendant company, visited plaintiff's house at 1.30 on April 6th, with Dr. Hopkinson, and felt no vibration at all, except when anyone moved in the rooms. This house was a very old and most imperfect structure, and a hansom cab passing down the street caused the house to shiver. He could find no vibration due to the defendant company's machinery, but a slight vibration caused by the printing machinery at *Tit Bits* office.

Mr. GRUNING, architect and surveyor, gave similar evidence.

Mr. WM. HY. PATCHELL, electrical engineer in the employ of the defendants, said the amount put out by them depended upon how much the public drew. He had visited Mr. Dart's house, and did not notice any vibration, except what was due to the age and shakiness of the building. They did not put more engines at work than were required to satisfy the demands of the public.

The case was again adjourned.

Further evidence was called for the defence on Wednesday.

Mr. CHARLES ERNEST PRESTON, solicitor, said, his office was in Maiden Lane, and nearer to defendants' works than Mr. Dart's house, but he never felt any vibration.

Mr. EDWARD ROBINSON, editor of the *Garden*, at 37, Southampton Street, felt no vibration.

Mr. E. CLARKE, architect and surveyor, had made tests with quicksilver on plaintiff's premises for vibration. There was no vibration on his first visit, but subsequently he found a slight vibration on the second floor. The house was in a very bad and insanitary condition.

At the conclusion of speeches of counsel, the case was adjourned for the jury to visit the premises in question.

COOK v. ST. JAMES'S AND PALL MALL ELECTRIC LIGHT COMPANY, LIMITED.

IN the Chancery Division of the High Court of Justice, on Tuesday, the 27th inst., the trial of this action came before Mr. Justice North.

It appeared from the opening statement of Sir HORACE DAVEY, Q.C., that the plaintiff was the owner in fee simple of a house and premises situated in St. James's Square, Middlesex, upon which a club called the Wyndham had for many years been carried on. The plaintiff was a member of that club. In 1888 the defendants acquired certain lands in Mason's Yard, which were adjacent to the plaintiff's premises, on which they placed powerful steam engines and machinery for the generation of electricity. Early in 1889 they began to work, and the working of the engines and machines had produced throughout the plaintiff's premises very great noise and vibration, which caused grievous annoyance, and was an intolerable nuisance to the members of the club, as well as actual injury to the plaintiff's premises and their value. The plaintiff, through his secretary, drew attention to the probability of the work causing injury, but they were assured by the defendants that their machinery was of such a kind as to ensure perfect silence and freedom from vibration. At the beginning of the working complaints were made, and a correspondence followed, with the result that the writ was issued claiming an injunction to prevent the injury. He (Sir Horace) submitted that there was such a nuisance as to entitle the plaintiff to the relief he claimed. Damages were not asked for.

At this stage the hearing of the action was interrupted for the purpose of awaiting the result of negotiations between the parties, which were successful, and the action was withdrawn from the cause list. The terms of settlement were not disclosed.

CORRESPONDENCE.

The Phonopore.

In your leader on the phonopore in your last issue, permit me to point out that this company's telephone block connectors for establishing a telephonic communication between signal boxes on railways gives every satisfaction, and that a resistance or condenser will not do what our instrument does.

On some lines the authorities will not allow the block bell to be used for calling attention to the telephone, and our system gives a special and distinct call (which no resistance or condenser can do) without in any way interfering with the telegraph system.

It is the best suited to railway work. It is placed on the bell or block wires, and the expense and maintenance of an extra wire which the ordinary telephone necessitates is saved.

With regard to the phonopore telegraph, it has been for the last two years at work in all weathers, and has done good and valuable work, and over 60 messages in the hour have been sent by it. It can be placed and works equally well on a duplexed wire, and is so working now in this country, and it is also working abroad.

I quite agree with your remarks as to the relative value of laboratory and actual line demonstrations, but, as this system has had a lengthened trial through all weathers and is still giving satisfaction, I think we have proved, and clearly so, as you say, that the success of the system is assured.

C. E. Spagnoletti, *Managing Director.*

The Phonopore Company, Limited,
Faraday House, Charing Cross Road, W.C.

Distribution of Electrical Energy by Gaseous Fuel.

I am much obliged to you for having noticed a letter which I wrote to the *Scotsman* on June 8th, on the subject of distribution of energy by gas. You have not, however, fully expressed in your notice the full importance of this question as applied to Edinburgh. In this beautiful city, without any manufacturing chimneys to speak of, any large steam engine installation for any purpose whatever, must of necessity be placed at a very great distance from the residential parts in which the electric light would be in demand. Given the best steam engine installation, it follows that the alternating high current system must here be used, unless there is to be, for many years to come, a great loss in making such an enterprise pay. The Town Council of Edinburgh have taken the matter into their own hands, and have refused to sublet their concessions to a company, one or two of which are quite ready to take the matter up. The cost of carrying the leads, and in opening the streets through districts of working class property, will far exceed that which could be accomplished by running a gas main to convey producer gas made from the troublesome by-product in this city, namely, coke. The illuminating power of Edinburgh gas is about 27 candles, and is therefore very expensive, costing 3s. 10d. per 1,000 feet. This is brought about in consequence of the use of cannel coal, and the result is that the coke is of a very inferior quality for household and other ordinary uses. It is sold at the Edinburgh gas works, wholesale, at 4s. per ton, and can, in any ordinary producer, be converted into gas by a jet of steam and air under a close fire-grate, and can be delivered in considerable quantities to small or large electric stations at the cost of about 2d. per 1,000 feet. Moreover, where this heating gas passes through a line of working-class property, a considerable demand would spring up for use in cooking stoves, which in our high Edinburgh tenements would get rid of carrying up coal, and ashes down, a great boon in such hot weather as we are experiencing now, and in winter apartments might be warmed in a similar manner. There has been a considerable discussion in Edinburgh as to the propriety of our Town Council undertaking the lighting of the city, and it has been very justly said that, to put down a proposed installation costing £100,000, will entail a serious loss, at any rate for some years, on the ratepayers, if the current is supplied at anything like a reasonable price. The argument used is, that working men (otherwise described by Mr. Gladstone, the masses) ought not to be taxed for supplying a luxury to the classes, and in this I think they are perfectly right. The Town Council, therefore, ought to see to the best system being adopted, which would immediately, or approximately so, give a return for the capital expenditure, and this, I maintain, can best be effected by the distribution of non-illuminating cheap gas. Your reference to Prof. Kennedy, and my being too late, as far as Edinburgh is concerned, I do not think will affect the question very much, as we Scotchmen here move rather slowly. I think it will be in the direction of Prof. Kennedy's interests to advise the best scheme for our city to be adopted, and therein he will work (if he agrees with me) with the gas commissioners. I have been informed that he has advised the use of gas engines in the case of Belfast from illuminating gas. If that is true, he will probably be able to give his reasons for having departed from his preference for a triple expansion steam engine made near London and installed in Glasgow and other places in Scotland, which it is well known is the birth place of not only the triple, but the quadruple expansion engine. Prof. Kennedy is a Scotchman, trained in Edinburgh, and in these days

of home rule I would advise him not to send coals to Newcastle, but other things being equal, or nearly so, to get as much of his work as he can, executed for the requirements of Scotland by Scotsmen. I may say that I have no interest in gas engines or gas producers, but rather otherwise, being a manufacturer of steam engines and hydraulic machinery, and I may add that, after mature consideration, I am about to replace a triple-expansion steam engine in Rosebank Iron Works with a gas engine of about 200 horse-power, to be supplied with gas made from coke. My immediate interest is that I have had my house for the last few years lit up with electric light, the energy being supplied by a gas engine and battery, and I am very anxious to have the current laid on in the best and cheapest possible manner, so that I can stop the working of my small gas engine, which, however, consumes less of our expensive gas per unit of light than I burned before in the ordinary way. Perhaps Prof. Kennedy will kindly criticise this letter if he has time.

A. W. Brown.

Rosebank Iron Works, Edinburgh.

Relative Safety or Danger of Electric Light Current.

Pressure of business last week prevented me replying to Messrs. Lawrence and Kirk's remarks upon this subject, which criticism I venture to say is a little wide of the mark, as any one interested in the subject will see on perusal of Dr. Waite's letter, which appeared in the REVIEW of May the 5th. In that communication, Dr. Waite gives his views very clear and explicit, and then seeks to obtain the opinion of electrical experts as to the adoption of alternating and high pressure mains being used, including the continuous arc circuit currents as supplied by central stations. Hence in this important discussion, whether the views of the writer be for or against the use of either of these various systems being utilised for electro-medical and electro-surgical work, such opinions should be clearly defined, because by this means the subject can then be more fully analysed, and the merits and the demerits of each system explained and discussed, which recorded information cannot fail to be of great use to medical men. So far as my own contribution goes upon this subject, I stated my views, as I always do, clearly, and without fear of contradiction. I am, therefore, glad to see that such expert authorities as Messrs. Lawrence and Kirk agree with me on all the more important points, especially that part which relates to continuous currents for electro-medical work, the use of which I entirely agree with them, provided such currents are "*chemically generated*," and for all-round work of the average physician, I am personally convinced that they are the best, cheapest, and most reliable, and without doubt the very safest for carrying out all delicate electro-medical and electro-surgical operations. Messrs. Lawrence and Kirk state in their letter that they supply batteries as well as current controllers; I may say "so do we," but I have no desire to use the pages of the REVIEW to discuss the merits of the articles sold by my firm, but prefer to let the goods speak for themselves, as I consider this is the proper way to settle all commercial questions of this kinds. I note that the subject under discussion (as first commenced in the REVIEW) has formed a subject matter for discussion in several Continental papers and American technical journals, hence it shows that the subject is looked upon as one of National importance, and it is to be hoped that central station managers will contribute full information relative to the working of plants installed in their various circuits (if any have been so fitted), for an ounce or two of practical experience is worth a ton of theory in matters of this kind. I may say I always make it a rule to express my views independently (whether they be for or against any particular section), although I am aware it is sometimes a most difficult matter to put one's views into print so as to be fully appreciated by all concerned; at the same time I think if Messrs. L. and K. will peruse my letter again and compare it with those of Dr. Waite and other writers, they will see that my remarks and criticisms come well within the debate, and certainly not a bit too severe when one comes to consider the danger in store for those operating unmanageable electric circuits. The publication of my letter upon this subject has evidently been read with interest by many, because I have received numerous enquiries from medical men and electricians asking special questions not alluded to by me; one letter is from a well known believer in the merits of continuous current transformers, another from a staunch believer in alternating current distribution systems, which gentleman asks point blank if I am entirely opposed to the extension and adoption of the now popular alternating current. My answer to this question is most certainly not; in fact, I may say that I am rather the other way inclined, provided that they are carefully and properly installed and utilised for lighting, heating, cooking, and ventilating purposes, because they are the cheapest, and also for the simple reason that such currents are now practically understood, and as generally installed, are quite safe, and the most convenient for general commercial purposes, as above described; but when it comes to the utilisation of the alternating or high potential currents, or even continuous current transformers being utilised for delicate operations in electro-medical and electro-surgical work it is another matter, and I am personally dead against the use and adoption of either such currents for these purposes, not only as regards safety but economy as well. Fancy probing an ulcer, drawing a tooth, or applying a current to the ear in case of partial deafness, or carrying out a very delicate internal operation requiring, perhaps, only a few watts, calculated at a cost of 6d. or 8d. per Board of trade unit, in the face of the known variable changes in pressure of the E.M.F., also the periodicities of some alternating current systems, leakage of mains, and perhaps simply trusting to a bit of fuse wire (which, if it be tin), is not reliable, by reason of its happy knack of corroding, or, again, relying even to the supposed safety of magnetic cut-outs, which are known to change according to the state of meridian and atmosphere; consequently, for any scientific expert to attempt to use or recommend their application in face of the above facts, is, to my mind, "a penny wise and pound foolish policy," and until some practical expert, who knows more than myself, can convince me by hard solid facts to the contrary, I shall continue to recommend chemical batteries, and do my level best to get the medical fraternity to continue to use them, as I conscientiously believe them to be the best. Undoubtedly the question of regulating and controlling the current is quite as much of importance in primary and secondary battery work as in main current supply, especially for electric baths and numerous other applications. I may say I am in favour of adopting a water resistance, and from my experience, I find the Bailey current controller about the very best and most convenient appliance for this purpose, especially as you can use water of the same temperature of the bath, which is an advantage; and as this appliance can be used under the absolute control of the patient, whose feelings are the best judges of the quantity of current his or her body is able to stand, I consider the "Bailey" is the very best and most scientific controller in the market. What we want in this discussion is to get at the truth of the whole matter, and a time test is the only test which can decide the bone of contention which now exists between admirers of high and low potential currents being utilised as and for the purpose under discussion.

Arthur Shippey.

June 21st, 1893.

An Explanation by Mr. F. L. Rawson.

I have had my attention called to your last issue in which you state that a receiving order had been made against me, and as this statement is, of course, prejudicial to me, I would be glad if you would kindly insert this letter.

As it was important in the interests of the shareholders that Woodhouse & Rawson United should not go into liquidation before the end of last February, I gave various guarantees to several parties in order to enable the company to continue their business, obtaining from the company ample security for such guarantees. Recently one of the guarantees brought an action against me, and obtained judgment by default, and although I stated that I could not pay any one guarantee until I had settled with all the other guarantees, and that I would be able to arrange this in a short time, they applied for the appointment of a receiver.

At this time I was in negotiation with the receiver of Woodhouse & Rawson United, and ultimately arranged with him that I should give up to him the securities that I had

received, and that he should pay off the guarantees, but the day before the application for the appointment of a receiver was made, he informed me that he found that he was not legally able to carry this out. In order to enable me to get the matter settled in another way, the legal proceedings were then adjourned, I understood, until the 23rd instant, but it seems that they were adjourned until the 21st, and on that day the guarantees had a receiving order made against me, in my absence, stating on the receiving order that I was present. On the following day I heard of this and applied to the Court for a stay of all proceedings, which was granted immediately, and to-day the receiving order was cancelled. On the 22nd, having settled with all the guarantees, I paid the amount of the guarantee.

F. L. Rawson.

Heating and Cooking by Electricity.

In connection with the article on heating by electricity by Mr. Rankin Kennedy, in your issue of June 16th, and Mr. Albert Gay's letter in your last issue, it may interest both of these gentlemen to know that Mr. Ferranti applied for a patent on January 15th, 1887 (more than 3½ years before either of them), for heating by induced currents.

Some time ago I endeavoured to ascertain who first described this exceedingly promising method of electric heating, and, so far as I have been able to gather, Mr. Ferranti was first in the field. I understand that the patent I have referred to, viz., No. 700 of 1887, is still in force.

David Cook.

How to Calibrate Voltmeters.

I should be glad to know the readiest way of calibrating voltmeters. Will any of your correspondents state what method they employ?

A.M.I.E.E.

NOTES.

Advertisement or Otherwise.—In the *English Mechanic and World of Science* last week there appeared, under the heading of "Answers to Correspondents," the following:—

> The most perfect form of electro-massage treatment is successfully carried on daily at the Medical Battery Company's Institute in Oxford Street, under the skilful medical supervision of fully qualified English physicians and surgeons, by experienced masseurs and masseuses. Rupture, deafness, corpulence, superfluous hairs, and wrinkles are also treated by specialists possessing sound practical knowledge in their different departments. If you cannot call for free private consultation, send at once for descriptive pamphlet and book of testimonials, which will be sent post free. Note.—The Medical Battery Company's Institute, 52, Oxford Street, London, W., is the only completely equipped electro-medical establishment in Europe.

In the very next column, under "Useful and Scientific Notes," we find this:—

> Holloway's Pills give potency to the nervous system, which is the source of all vital movements, and preside over every action which maintains the growth and well-being of the body. They are most unfailing antidotes to indigestion, irregular circulation, sick headache, and costiveness, and have attained the highest reputation.—[ADVT.]

Holloway's pills are, so far as we know, perfectly harmless; the appliances of the Medical Battery Company have recently occupied the attention of the Courts of Law. But the thing we wish to point out is that in one instance there is nothing to indicate that the notice is an advertisement, whereas in the other appears the stereotyped [ADVT.].

Maidstone Electric Lighting.—The Electric Lighting Committee of the Local Board have prepared their report, in which they recommend the consideration of the offers of Messrs. Sharp and Kent and Messrs. Bourne and Grant for the whole of the public lighting; they also make the following recommendations:—That application be made to the Board of Trade for an extension of time; that the Local Board have the right to purchase the undertaking at the end of 10 years on certain terms; that a suitable site be fixed upon and the station erected; that the maximum price per unit be 8d.

Telephonic Communication for Rhyl.—The National Telephone Company, Limited, have decided to extend their line from Flint to Rhyl, and establish an exchange office in the town.

Lambeth Electric Lighting.—At the last meeting of the Guardians there was some discussion as to the advisability of obtaining an expert's opinion regarding the cost, practicability, &c., of introducing electric lighting into Renfrew Road Workhouse and Infirmary. This was the remark of the chairman when a member made the proposal to consult Mr. Preece, or some person whom he might nominate:—"You won't be mad enough to propose this expenditure at the present state of electric lighting?" This strong statement drew forth comments from a number of those present, who advocated the adoption of electricity, and ultimately it was resolved, with only two dissentients, that £30 be expended in obtaining an expert's opinion on the subject.

Paris Electric Lighting.—A new company has just been formed at Paris for working the sector of the left bank. The concession of this sector was granted after a deliberation of the Municipal Council, July 23rd, 1890. Until now no company could be formed by M. Naze to carry out the necessary operations. The new company starts with a capital of 3,000,000 francs, represented by 6,000 shares at 500 francs each. Besides these, 12,000 beneficiary shares have been created, which will share in the special profits. The first council of administration is composed of Messrs. Naze, Gibbs, Mourlon, Guinotte, and Valère Mabille. For his support Mr. Naze receives a sum of 375,000 francs and 6,000 beneficiary shares. A few months ago M. Naze bought or rented some small electrical energy works, established in 1888, in the Place du Panthéon, by the Oerlikon Company. These works are to supply part of the sector. The new company will probably establish some works better suited to the sector to be supplied.

Orpington Electric Lighting.—Mr. J. Torr Todman, electrical engineer, London, has prepared a scheme for the proposed electric lighting of Orpington, Kent. The system recommended is high tension alternating current. The central station will be at Hodsell's mill, and the motive power obtained from the existing steam engines, which are of sufficient power to run 250 16-C.P. lamps (or with increased boiler power 350 to 400). The alternator or generator will be a "Gülcher" machine capable of maintaining 400 16-C.P. lamps (incandescent); the main cable will be of Callender make. The estimated cost of plant, laying mains and branch cables, and fixing transformers, is put down at £905, and the annual working expenses at £277. The Orpington Committee of the Bromley Rural Sanitary Authority have recommended that facilities should be given to any company formed for the purpose of electric lighting the district, and that the necessary permission for breaking up the roads be given.

Chatham and Rochester Electric Lighting.—An extraordinary general meeting of the Chatham and Rochester District Electric Lighting Company has been held to consider the contracts entered into by the chairman, Mr. Henry Jasper, and the company, whereby Mr. Jasper contracts to supply and erect certain works, plant and machinery for the company, for the sum of £18,630, payable in 3,726 fully paid shares of the company. It appeared that in consequence of pressure by the Board of Trade, certain works had to be executed under the risk of the company's order being revoked as the penalty for omission, and there being some difficulty in obtaining the requisite capital, Mr. Jasper undertook to provide the capital, in consideration of the 3,726 fully paid shares being transferred to him. The shareholders were asked to adopt the contracts, but there being a disposition on the part of the shareholders present to go fully into the figures, Mr. Jasper's actual outlay appearing to be £9,315, though Mr. Hurrell, the engineer, said the work might cost £20,000 or £30,000, in which case Mr. Jasper would have to bear the loss, it was agreed that before any resolution should be put before the shareholders, that there should be a conference between a committee of the shareholders with Mr. Jasper upon the subject.

Telephones in Greece.—The Greek Administration are about to establish a service of 300 subscribers, between Athens and the Piræus.

Telegraphic Communication between Paris and Algiers.—Direct telegraphic communication between Paris and Algiers is now carried on by means of the Hughes apparatus, the Willot relay being used. The line consists of 1,000 miles of open work and 560 miles of submarine cable.

The Cassagnes Steno-Telegraph.—Experiments are about to be made with this apparatus by the French Administration in Paris, the circuit arrangements being such as would be employed in actual practice for the service of the Press.

Sutton Electric Lighting.—Three letters from engineers with regard to the electric lighting of the town have been considered by the General Purposes Committee, who, however, have deferred making any recommendation until after it has had time to consider the result of inquiries which are being made by the Clerk.

Moffat Electric Lighting.—The Commissioners have obtained a report from Messrs. Woodhouse and Rawson, electrical engineers, Glasgow, with respect to the electric lighting. It is proposed to use the waterfall at Skellywell Mill, on the river Evan, Mr. William Younger, of Auchencastle, having consented. Exclusive of buildings, &c., but including all the requisite plant and fitting up the same, the cost is stated at £3,879. The expense of arc accumulator batteries or small accumulator distributing stations for the supply of private houses is not included. The report states that after supplying the arc lamps in the streets the light available for sale would equal £1,946 13s. 4d. a year.

Metropolitan Electric Supply Company.—According to the *Contract Journal*, the reception of the accounts of the Metropolitan Electric Supply Company, Limited, gave rise to discussion at the Paddington Vestry as to the wisdom of the Vestry in declining to carry out the supply of electric light. It appears that after two years' work the company had made a profit of 2 per cent. Colonel Barchard congratulated the Vestry in declining to embark on the enterprise, as some members desired to do. The result was, that the Vestry had got its money and the company the electric light. At present the company had only 297 customers in Paddington.

A Peculiar Accident due to Lightning.—During a storm a week or so ago a remarkable thing occurred at a station in the Grenfell district. Two working bullocks were grazing in a paddock; one which had its head close under a wire fence was struck dead by lightning, the animal next him being knocked down and stunned. The course of the current could be plainly traced along the wires of the fence, and is supposed to have made a complete circuit of the paddock, circling the straining posts, and then apparently passing along the whole line of communication. The wire in many places was fused, weeping drops of shot all along its line. Our first impression on reading this was that a contemporary had been down in the country.

The Azores Cable.—*The Financial Times* comments as follows on the matter of the Azores cable:—"British enterprise has just scored a point in Portugal. For a long time it has been a question of laying a cable between that country and the Azores, and protracted negotiations have been carried on with French and English companies. At length the contract has been finally secured by the Eastern Telegraph Company, of London, which has obtained it against the Société Française des Télégraphes Sous-Marins. We understand that the last-named company has forfeited £10,000 caution money to the Portuguese Government. The new cable will connect Portugal with St. Michael, in the Azores, and when this is completed it is proposed to extend the line to the Antilles, and thence to Bermuda, forming thus a fresh channel of communication with the United States. As a nation we are not very popular in Portugal just now, and the fact that the Cortes have just ratified the contract with the Eastern Telegraph Company is the more satisfactory to us."

Cable Communications.—The Fao-Bushire cable was interrupted on June 25th.

A Telephone Exchange at Leamington.—Last Monday an exchange in connection with the National Telephone Company's system was opened at Leamington.

Haddington Electric Lighting.—The Town Clerk is making enquiries as to the utilisation of the water power at East Mill for electric lighting the streets. He is also in communication with an electrician regarding the matter.

Redruth Electric Lighting.—The company which was to have been formed for supplying Redruth with light by electricity has been abandoned, owing to lack of public support. There were a good many shares applied for, but not enough to warrant the formation of the company.

The City and South London Railway Bill.—This Bill came before a Select Committee of the House of Lords on Tuesday, but the opposition to it having been abandoned, the Bill was referred to Lord Morley's Committee as unopposed. By the Bill, the City and South London Railway Company are empowered to extend their electric railway from King William Street to Islington, and an extension of time is granted within which to construct their authorised extension from Stockwell to Clapham.

Spencer-Balfour & Co. and the Electric Construction Corporation.—The Electric Construction Corporation it appears is not altogether unaffected by its acquaintance with Spencer Balfour and his confederates. On Tuesday last, on resumption of the examination of the officials of the Building Securities' Company, Limited, in the London Bankruptcy Court, before Mr. Registrar Emden, Mr. Geo. Dibley (who was formerly a director of the E.C.C., and also of the London and General Bank), in the course of cross-examination evidenced as follows:—

The REGISTRAR: Will you explain how it is that investments were made in other companies, especially in underwriting the £100,000 worth of shares in the Electric Construction Corporation, Limited?

WITNESS said it was true that £15,000 worth of the shares were placed in his name, but it was all done by Mr. Balfour without his knowledge or consent. When he discovered what had happened he had rather a warm interview with Balfour on the subject, and that gentleman assured him that the transaction would result in a profit to the company, and witness was satisfied with the explanations offered. . . . . He resigned his seat on the board in July, 1891, his reason being that he was dissatisfied with a large investment made by Mr. Balfour in the Electric Construction Corporation shares, and also because the directors were constantly being required to sign promissory notes against loans obtained by the company. He had expressed his intention of retiring a year previously, but Mr. Balfour said that his action would have been disloyal, and witness therefore remained. He had never made any independent inquiry into the balance-sheets of any of the companies with which he had been connected.

The Institution Conversazione.—On Friday evening last, a large company of leading electricians and scientific men in general, assembled at the annual conversazione of the Institution of Electrical Engineers, held at Princes Hall, Piccadilly. Mr. W. H. Preece, President, assisted by Miss Preece, received the visitors, of whom there was a very large attendance, the rooms being densely crowded. The pleasure of the evening was materially enhanced by the performance of an excellent musical programme, by the band of the Royal Horse Guards Blue, under the conductorship of Mr. Charles Godfrey. Many distinguished persons were present, the following being the names of a few of them:—Lord Kelvin, P.R.S.; Sir George Berkley, K.C.M.G. (Past President Inst.C.E.); Mr. A. Giles (President of Inst.C.E.); Mr. Edward Woods (Past President Inst.C.E.); Sir Frederick Bramwell, F.R.S.; Sir David Salomons, Bart.; Sir James Crichton Brown, M.D., F.R.S.; Sir Owen Roberts, D.C.L.; Earl Russell, Col. Haywood, Sir B. Baker, K.C.M.G.; Gen. Webber, C.B.; Dr. J. Hopkinson, F.R.S.; Dr. J. H. Gladstone, F.R.S.; Dr. E. Frankland, F.R.S.; Dr. W. H. Perkins, F.R.S.; Prof. G. Forbes, F.R.S.; Prof. W. G. Adams, F.R.S.; Prof. D. E. Hughes, F.R.S.; Prof. R. Meldola, F.R.S.; Prof. Perry, F.R.S.; Prof. S. P. Thompson, F.R.S.; Prof. A. B. W. Kennedy, F.R.S.; Mr. A. Siemens, M.Inst.C.E.; Mr. Crompton, M.Inst.C.E.; Mr. C. E. Spagnoletti, M.Inst.C.E.; Mr. J. W. Swan.

Theatre Electric Lighting.—The Paragon Theatre of Varieties will be closed for one month from July 1st for re-decoration, lighting by electricity and heating.

Lancaster Electric Lighting.—Mr. A. S. Barnard, at present superintendent of the installation department of the Corlett Electrical Engineering Company, Wigan, has been appointed borough electrical engineer, at a salary of £120 per annum. There were 30 applicants for the post.

Dart v. Electricity Supply Corporation, Limited.—The report of this case will be found in our Legal columns. On Thursday (yesterday) morning the jury, after viewing the premises and hearing the summing up, found a verdict for the defendants. Mr. Justice Cave gave judgment for the defendants with costs.

NEW COMPANIES REGISTERED.

William Parnall and Company, Limited (39,047).—This company was registered on the 14th inst., with a capital of £30,000, in £10 shares, to acquire the business of a grocer's outfitter, now carried on by Wm. Parnall at Victoria Street, Temple Street, Bristol; at 15, Seething Lane, E.C., and 16, Hanging Ditch, Manchester, under the style of Wm. Parnall & Co., and to carry on, in their respective branches, the trades of scalemakers, smiths, brassfounders, weighing machine manufacturers, engineers, electricians, and suppliers of electricity. The subscribers (with 1 share each) are:—Wm. Parnall, 19, Beaufort Road, Clifton, Bristol, grocer's outfitter; F. Thomas Johns, 5, Brampton Grove, Cheetham, Manchester, traveller; F. E. Ellison, 43, Ashley Road, Bristol, accountant; P. J. H. Lloyd, 7, Redland Park, Bristol, tea merchant; T. J. Beard, 80, North Road, Bishopston, Bristol, engineer; A. Harvey, 24, Franklyn Street, St. Paul's, Bristol, manager; G. B. May, Chertsey Road, Redland, Bristol, gentleman. The first directors are: Wm. Parnall, G. B. May, and F. T. Johns. Qualification, £100 per annum. Remuneration, to be paid out of the funds of the company. Registered by Salisbury & Griffiths, solicitors.

Orme's Electric Signal Syndicate, Limited (39,057).—This company was registered on the 15th inst. with a capital of £7,500 in £1 shares, to acquire British patents, including one dated November 28th, 1891, and numbered 20,742, and a provisional patent dated February 17th, 1893, granted to John Orme in respect of an invention relating to electrical and automatic signalling; to adopt an agreement made between John Orme and — Andrews; and to carry on the business of the company. The subscribers (with one share each) are:—J. Orme, 65, Barbican, E.C., electrical engineer; W. Godbold, 65, Barbican, E.C., printer; C. H. Avey, 181, Wick Road, Homerton, electrician; W. Powell, 117, Ilderton Road, South Bermondsey, glass blower; N. Mitchell, Brixton, brass finisher; S. Jennings, Grove Park, Denmark Hill, gentleman; W. M. Grimshaw, Priory, Prittlewell, gentleman. Table "A" applies, with few exceptions. Registered by L. E. Brasseur and Oakley.

North-Eastern Telephone Company, Limited (39,088).—This company was registered on the 20th inst. with a capital of £1,000 in 500 preference and 500 ordinary shares of £1 each, to carry on the business of a telephone, electric light, heat and power supply company, and in particular to establish, work, manage, control, and regulate telephone exchanges and works for the supply of electric light. The subscribers (with one share each) are:—G. H. Coates, 33, Mosley Street, Newcastle-on-Tyne, accountant; A. O. Challoner, Benwell Lodge, Newcastle-on-Tyne, share broker; G. H. Wear, Post Office Chambers, Newcastle-on-Tyne, insurance secretary; C. Thompson, 9, Deace Street, Newcastle-on-Tyne, consulting engineer; W. Cowill, Pilgrim Street, Newcastle-on-Tyne, ironmonger; S. Percy, Newcastle, plumber; T. Telford, 18, Marncliffe Street, Newcastle, gentleman. The rules of Table "A" usually apply. Registered by Waterlow Brothers and Layton, 24 and 25, Birchin Lane, E.C.

CONTRACTS OPEN AND CLOSED.

OPEN.

Belem (Brazil).—For lighting by gas or electricity the city of Belem, the capital of Gram Pará, Brazil, by contract. The conditions of contract and all particulars may be had on application to the Brazilian Consulate, at 6, Great Winchester Street, London, E.C., or at the Consulates of Liverpool and Glasgow.

Ealing.—July 18th. Provision and laying of electric light mains, transformers and accessories. For further particulars, see our advertisement pages.

Ealing.—July 18th. Wiring of public buildings, and for the provision of fittings and accessories. For further details see our advertisement pages.

Ealing.—July 18th. Building of engine and boiler house, &c., and accessories at the central station. For further particulars, see our advertisement pages.

Huddersfield.—July 1st. For the following materials and labour requisite for laying an electric supply main, for the Electric Lighting Committee:—1. Supply of 3-inch cast-iron spigot and socket pipes. 2. Supply of cast-iron junction boxes. 3. Supply of lead. 4. Supply of spun yarn. 5. Supply of concentric conductors, insulated with vulcanised India-rubber. 6. For the labour in excavating the trench, laying and jointing the pipes, fixing and connecting the junction boxes, and drawing in the cables. Specification and form of tender may be obtained upon application to Mr. A. B. Mountain, borough electrical engineer, Gasworks Street, Huddersfield.

Manchester.—July 10th. For erection of offices, &c., and entrance gateway at the electric light station, Dickenson Street, for the Manchester Corporation.

CLOSED.

Cardiff.—A special meeting of the lighting and electrical committee of Cardiff Corporation was held in the Council Chamber on Monday last. Tenders for the supply of boilers, machinery, and electrical apparatus were received and considered, there being 26 in all. The consulting engineer stated that, in his opinion, they could get all the machinery, &c., required, for about £10,600, if the different portions of material were supplied by different firms. Alderman Carey thought there should be no divided responsibility, and that the laying down of plant and machinery be given to some firm whom they could trust. There were eight tenders for the whole of the machinery and plant, namely:—

Messrs. John Fowler & Co., Leeds (without boilers)	£11,600
Messrs. Ferranti & Co., London (everything included)	12,700
The British Engineering Company (everything included)	12,200
Messrs. Latimer Clark, Muirhead (everything included)	11,500
Messrs. Crompton & Co. (everything included)	11,200
Messrs. Johnson and Phillips „ „	11,000
Messrs. Siemens Bros. „ „	10,900
Messrs. Woodhouse & Rawson „ „	10,800

There were 18 other tenders for portions only, or for types of machinery and apparatus, not in accordance with specifications. After deliberation, the committee decided to accept the following tenders:

Boilers, Messrs. Davey, Paxman & Co., Colchester.

Condenser, Messrs. James Watt & Co., Birmingham.

Engines, dynamos, switchboard, transformers, rectifiers, &c., Messrs. Siemens Brothers, Limited, London.

Lamps and special automatic cut-outs, Messrs. Johnson and Phillips, of Charlton.

The selection of lamp-posts and other small things has been deferred. The total amount of the tenders accepted is £10,200.

BUSINESS NOTICES, &c.

J. A. Berly's Universal Electrical Directory for 1893 (12th year), 784 pp. This standard work contains a larger amount of trade information than any other similar publication, and should be in the hands of every engineer or electrician. Free within the Postal Union for 4s.

The Volta Electrical Company, Limited.—A general meeting of the above company will be held at the offices of Rycroft and Bellhouse, solicitors for the liquidators, 2, St. Peter's Square, Manchester, on July 28th, at 3 p.m., for the purpose of having the liquidators' accounts, showing the manner in which the winding up has been conducted, and the property of the company disposed of, laid before such meeting.

Austin & Myers.—This firm having been served with a writ at the suit of one of their creditors, they have executed an assignment of all their estate to a trustee, to secure the due distribution thereof. A meeting of creditors is to be held to-day, at 3 o'clock p.m., at the White Horse Hotel, Armley Road, Leeds, when a statement of affairs will be laid before them.

Failure of an Electrical Engineer.—At Glasgow Bankruptcy Court on 23rd inst., William M'Whirter, electrical engineer, Campbell Street, Govan, appeared for examination. The trustee stated that as he had received full explanations regarding the estate, he had no questions to ask. The examination was closed.

Catalogues, Price Lists, &c.—There appears to be a great deal of ambition in these days among manufacturers of electric light fittings and similar firms, in regard to the publication of lists and catalogues of their manufactures and the goods traded in by them. Not content with an ordinarily printed account of the articles referred to, the idea of having some gorgeous display of colours, or other fascinating characteristic, seems now to be aimed at by the publisher. The latest attempt in this direction has been made by Messrs. Lea, Sons & Co., of London and Shrewsbury, but instead of being called a catalogue, they designate it a "portfolio." It consists of a number of loose sheets on which are given details of various designs of electric light fittings, such as electroliers, pendants, brackets, lamps, ship fittings, &c.; accompanying these sheets are others, on which are illustrations of the fittings artistically and tastefully coloured. This is a piece of work which does the firm great credit, as it has been well executed, although the colouring, which is hand work, is somewhat crude.

We have received catalogues of the National Electric Manufacturing Company (Eau Claire, Wisconsin, U.S.A.) one dealing with the direct current incandescent system, and the other descriptive of the National transformer system of incandescent electric lighting for long distance. The two catalogues are well illustrated. Another list details the installations of the National transformer system made in America prior to January 1st, 1893. Messrs. Shippey Brothers have been appointed sole European agents for the National transformer system, and intend shortly to hold stock in England of the National Company's specialities.

The Electric Construction Corporation.—We publish in another part of this issue a circular which has been issued by the Construction Corporation to its shareholders. The directors have come to the conclusion that a reconstruction is necessary. They recommend the adoption of a most drastic measure, being no less than wiping out of existence £300,000 of capital. This is a most serious step, and serves to show that the company must have been in a critical condition to necessitate this course. It is to be sincerely hoped that matters will henceforth proceed steadily towards the payment of good dividends. At any rate, the company can be congratulated upon two things: the departure of Mr. Jabez Balfour to a more suitable climate, and the acquisition of Mr. Emile Garcke as managing director; these two incidents should work wonders for the corporation.

The *London Gazette* contains notice that a petition for the winding up of the above company, subject to the supervision of the High Court of Justice, was, on June 26th, 1893, presented to the Court by Sir Daniel Cooper, of 6, De Vere Gardens, Baronet, a creditor of the said company. The petition is directed to be heard before the Court sitting at the Royal Courts of Justice, Strand, W.C., on July 8th, 1893; and any creditor or contributory of the company desirous to support or oppose the making of an Order on the said petition, may appear at the time of hearing by himself, or his counsel, for that purpose.

York Electric Lighting.—The York City Council Electric Lighting Sub-Committee has recommended the acceptance of the tender of Messrs. Siemens Bros. & Co. for the lighting of the city. Further consideration of the matter has been deferred; the whole committee has gone into an abstract of the reports submitted by Prof. Kennedy, such abstract to summarise the tenders of the following firms:—Messrs. Crompton & Co., Limited; Messrs. Siemens Bros. & Co., Limited; Messrs. C. A. Parsons & Co.; and the Brush Electrical Engineering Company; and to contain a statement showing the comparative cost of production in each tender in the area first proposed to be lighted, and in the proposed extension of such area, together with the amount required to pay interest and provide the sinking fund in connection with the capital outlay.

Arcas Plating Company, Limited.—The *London Gazette* contains a notice that a petition for the winding up of the above company, subject to the supervision of the High Court of Justice, was, on June 23rd, presented to the Court by Captain Frederick Braid Buist Sparks, a shareholder of the said company; and that the petition is directed to be heard before the Court sitting at the Royal Courts of Justice, Strand, W.C., on July 8th; and any creditor or contributory of the said company desirous to support or oppose the making of an Order on the said petition, may appear at the time of hearing by himself, or his counsel, for that purpose.

"The Atlantic Ferry."—This is the title of a book just published by Messrs. Whittaker & Co., in their popular edition. The book, which is from the pen of Mr. Arthur J. Maginnis, M.I.N.A., devotes itself to the particularisation of the various great shipping companies of the world, with their principal vessels and photographs of the founders of some of the companies. A large number of full-page illustrations of magnificent steamers and other vessels are well executed. As a collection of useful shipping history and information the book is very interesting.

Caution.—Some months ago in these columns we cautioned dealers with Amsterdam establishments to exercise great discretion in regard to new customers in that part of the continent. We are glad to see from a paragraph in *Money and Trade*, that the police authorities over there have taken the matter up, and have published a list giving the names and other particulars of the many Amsterdam firms who are now regarded with suspicion. The document embraces some 60 or 70 names.

City of London Electric Lighting Company, Limited.—Issue of 20,000 preference shares. The letters of allotment have been posted.

Russell & Co.—This firm's *employés* had their annual holiday on Saturday the 17th inst. The entertainment provided consisted of a trip on the river in a steam launch. Dinner was partaken of at Staines, and tea at Kingston concluded a most enjoyable day.

Electric Lighting of Business Premises.—The members of Seaham Harbour Co-operative Society decided, at a meeting held on Saturday last, to light their extensive premises by electricity.

CITY NOTES.

United River Plate Telephone Company, Limited.

THE directors' report, to be presented at the seventh ordinary general meeting, to be held at Winchester House on Tuesday, July 4th, 1893, at 12 o'clock noon, reads as follows:—

"The directors beg to submit to the shareholders the accompanying balance-sheet and profit and loss account, showing the result of the company's operations during the year ending March 31st last. After deduction of expenses in the River Plate, loss on exchange, debenture interest, and other London charges, the directors are pleased to report that the year's working has enabled them to write off £768 7s. 8d., the balance of taxes suspense account, £2,728 12s. 9d. for bad and doubtful debts, and to carry £3,000 to depreciation and renewal fund. There then remains a balance of £540 3s. 3d., increased by £365 9s. 9d., brought forward from the previous year, to £905 13s. The capital expenditure for the year amounted to £3,394 10s. 9d., and the working expenses in the River Plate were, at par of exchange, £57,668 19s. 2d., against £58,618 9s. 8d. in the previous year. Since March 31st last, the business of the company has kept pace with the general improvement in affairs in the Argentine Republic; it is expected that this improvement will continue, and that the company will soon be in a position to resume payment of dividends. The board desire to express sincere regret at parting with their esteemed colleague, Mr. J. Owen Unwin, who, in order to effect a reduction in the number of directors, which has been for some time contemplated, has resigned his seat at the board. Under the articles of association, Mr. Frank W. Jones and Mr. Frederick Green retire, and, being eligible, offer themselves for re-election. The auditors, Messrs. Cooper Brothers & Co., also retire."

The Electric Construction Corporation, Limited.

A CIRCULAR has been sent to the shareholders, signed by Sir Daniel Cooper, reading as follows:—To the shareholders,—Since the last general meeting your directors have carefully considered the best means of placing the corporation in a sound commercial and financial position, and they are glad to be able to report satisfactory progress in this direction. Important reductions have been made in the general expenses, the directors have reduced their remuneration, and such further economies as will not interfere with efficiency will be introduced as opportunity offers. During the past year seven directors have vacated their seats, and three new directors have been appointed, and the board has thus been practically reconstituted. The directors, recognising the necessity of a commercial manager for the economical and efficient administration of the business, consider themselves fortunate in having secured as managing director Mr. Emile Garcke, whose experience and success as manager for several years of the Brush Electrical Engineering Company specially qualify him for the position. Mr. James Gray has recently been appointed secretary. The directors have also much pleasure in reporting that the important engineering and manufacturing contracts carried out by the works director, Mr. Thomas Parker, have not only given entire satisfaction but established for the corporation a high reputation for excellence of design and workmanship. In accordance with the views expressed at the general meeting, it has been the duty of the reconstituted board to determine, according to the best of their judgment, whether the capital of the corporation is adequately represented by its assets and after careful and anxious deliberation the directors have come to the conclusion that a re-arrangement of capital by reconstruction is both expedient and necessary. This, they are of opinion, can be most advantageously carried out by the formation of a new company with reduced capital. As a consequence of the reconstruction, future profits would be applicable to payment of dividends instead of to making good the deficiency on capital account. It is proposed that the new company shall be called "The Electric Construction Company, Limited," with a nominal share capital of £400,000, divided into 150,000 ordinary shares of £2 each and 50,000 7 per cent. cumulative preference shares of £2 each, with £150,000 first mortgage debentures and £100,000 second mortgage debentures, the latter redeemable by half-yearly drawings in about 15 years; and that the capital of the corporation be exchanged for capital in the new company on the following terms:—(*a*) Ordinary shareholders to receive two fully-paid £2 shares of the new company for each fully paid £10 share of the corporation. (*b*) Preference shareholders to receive five fully-paid 7 per cent. cumulative preference shares of £2 each (£10) for each £10 fully-paid 7 per cent. cumulative preference share of the corporation. (*c*) Holders of founders' shares to receive two fully-paid £2 ordinary shares of the new company for each £10 founders' share of the corporation. (*d*) Holders of first and second mortgage debentures to receive first and second mortgage debentures of the new company of

the same nominal amounts, and carrying the same rate of interest, as the first and second mortgage debentures of the corporation. (c) Holders of income bonds to receive two fully-paid ordinary shares of £2 each for each income bond of £10. The first mortgage debentures will constitute a first charge, and the second mortgage debentures a second charge upon the property, assets and undertaking of the new company, present and future, and each series will be secured by a separate trust deed, with the same trustees as those now acting under the existing trust deeds. The statement given below shows the present capital of the corporation and the capital of the proposed new company, to be issued in exchange. It is proposed that the new company shall take over the business with all liabilities and assets as from July 1st, 1893. The works of the corporation at Bushbury are generally admitted to be the best of their kind in the kingdom, and the plant is specially adapted to the business, and is in very good condition. The patents owned by the corporation are valuable, and the electro-chemical patents taken out by Mr. Parker, and the technical staff, especially give good promise of profitable results. The ability of the corporation to carry out large and important contracts has been shown by the successful completion of the Liverpool Overhead Electric Railway, of the South Staffordshire electric tramways, and of numerous electric lighting contracts and other applications of electricity in London and the provinces. Having most carefully considered the whole position, the directors are of opinion that the capital of the new company will be fairly represented by its assets, and that the proposed reconstruction deals equitably with the various interests, and places the company in a strong position for doing such an amount of profitable work as may be reasonably expected to yield a satisfactory return upon the reduced capital. By reason of the reorganisation of the business, which has been in progress for some months past, it is impracticable at present to give the result of the working during the portion of the year which has elapsed, but perhaps the best evidence of the confidence of the board in the future of the company is that several of its members have since the last general meeting acquired shares, advanced money, or otherwise supported the corporation to an amount exceeding £30,000. Accompanying this report is notice of a special meeting to consider, and, if deemed advisable, to pass the resolutions appended. It is hoped that all shareholders will endeavour to attend, but forms of proxy are issued to enable shareholders to express their conclusion on the proposals now submitted. The board attach much importance to having the support of every shareholder.

STATEMENT SHOWING THE CAPITAL OF THE ELECTRIC CONSTRUCTION CORPORATION, LIMITED, AND THE CAPITAL OF THE PROPOSED NEW COMPANY.

CAPITAL OF THE ELECTRIC CONSTRUCTION CORPORATION, LIMITED.			CAPITAL OF THE NEW COMPANY TO BE ISSUED IN EXCHANGE.	
Six per cent. first mortgage debentures in bonds of £100 each	£150,000	*To be exchanged for*	Six per cent. first mortgage debentures, operating as a first charge upon the undertaking and property of the company, and secured by trust deed ... ... *Of these, £24,600 will be deposited as security, but will be available for issue.*	£150,000
Six per cent. second mortgage debentures, redeemable by half-yearly drawings within 15 years, with income bond of equal amount attached, entitled upon redemption of the corresponding debenture to rank in front of the ordinary shares and to bear interest at a rate equal to dividend paid on ordinary shares	100,000	do.	Six per cent. second mortgage debentures, to rank next after the first mortgage debentures secured by trust deed, redeemable by half-yearly drawings within 15 years ... *Of these, £50,000 will be deposited as security, but will be available for issue.*	100,000
Income bonds	100,000		20,000 ordinary shares of £2 each, fully-paid in exchange for the income bonds ... ... *Of these, 10,000 shares will be issued and held as security.*	40,000
Seven per cent. cumulative preference shares of £10 each	29,260	do.	14,630 fully-paid 7 per cent. cumulative preference shares of £2 each	29,260
Ordinary shares of £10 each, entitled to surplus profits up to 10 per cent., and to one-half of remaining profits...	499,000	do.	99,800 fully-paid ordinary shares of £2 each, in the proportion of two new shares for one old	199,600
100 founders' shares of £10 each, entitled to one-half of surplus profits after 10 per cent. has been paid on ordinary shares	1,000	do.	200 do. do. do. ...	400
	£879,260			£519,260

Accompanying the directors' statement is the following notice:—A meeting of the holders of the first mortgage debentures of the Electric Construction Corporation, Limited, will be held on Wednesday, the 5th day of July, 1893, at 12 o'clock noon, at Worcester House, Walbrook, in the City of London, in accordance with the provisions of the fourth schedule to the trust deed to secure the first mortgage debentures, for the purpose of considering, and, if thought fit, of passing, the following resolutions:—1. This meeting hereby sanctions the scheme for the reconstruction of the Electric Construction Corporation, Limited, set forth in the draft resolutions produced to the meeting, so far as the same affects the holders of the first mortgage debentures of the corporation. 2. This meeting approves the forms of the first mortgage debentures of the new company and the trust deed to secure the same, which have also been produced to the meeting, and sanctions the exchange of the first mortgage debentures of the corporation for first mortgage debentures of the new company. 3. This meeting, pending the exchange of the first mortgage debentures of the corporation for first mortgage debentures of the new company, hereby suspends the right of the holders of the first mortgage debentures to take or prosecute against the corporation any legal proceedings relating to the debentures.

Electric and General Investment.

THE third ordinary general meeting of the shareholders of the Electric and General Investment Company, Limited, was held on Tuesday last, at Winchester House, Mr. G. Herring presiding.

The CHAIRMAN, in moving the adoption of the report, said the company had an authorised capital of £200,000, a subscribed capital of £100,000 and a paid-up capital of £20,000, so that while they had good credit they had but a small capital to pay a dividend on. The dividend recommended on the present occasion was £6,000, being sufficient to pay only 3 per cent. on the authorised capital and 6 per cent on the subscribed, but sufficient to pay 30 per cent. on the paid-up capital. He thought this showed the success of the company. The reserve fund (founders' shares) was invested in a manner which the directors thought would ultimately turn out to the advantage of the founders, while the reserve fund of the ordinary shares was invested in the business of the company. For convenience sake they had taken the investments at cost. He knew that such a policy often provoked an enquiry in the shareholders' minds as to whether the investments were worth the amount placed against them, so that he would assure them that, having made an estimate, the Board found that even at the present depressed prices they were not over-valued. A final dividend on the ordinary shares at the rate of 30 per cent. per annum for the second half of the year, making 25 per cent. for the year, was now recommended. Counting this, the directors had paid the shareholders back nearly 12s. 6d. out of their £1, and they had placed 10s. per share to reserve, so that the shareholders had received nearly 22s. 6d. for every pound invested. He wished to remind shareholders that although in good years the company might expect to make large dividends, they might have bad years, when a smaller distribution would have to be made.

The motion was seconded by Mr. J. B. BRAITHWAITE, jun., and carried.

Electricity Supply Company of Spain, Limited.

THE annual general meeting of this company was held at 15, St. Helen's Place, E.C., on Monday, 26th inst., under the presidency of Lord Castletown, the chairman.

In moving the adoption of the report, the chairman called attention to the fact that the business continued to steadily improve, there being a distinct advance last year as compared with 1891, and a further improvement during the first four months of this year. There had been a change in the management at Madrid early this year, one of the results of this being a reduction in the office staff, saving £500 per annum, whilst an economy of £1,000 had been effected at the works. In face of the constant increase in business, however, it would not be practicable to make any great permanent saving in the latter direction. The gross earnings for 1892 were £24,228, as against £15,770 in 1891. The gross earnings from January 1st to May 31st, 1893, were £10,328 7s. 4d., against £7,677 0s. 10d. in 1892. Business in Madrid for 1891 had resulted in a loss of £1,229 10s. 7d., whereas in 1892 the result was a net profit of £7,084 2s. 5d. The number of lamps, calculated on a basis of 40 watts per lamp, was on January 1st, 1892, 18,752, January 1st, 1893, 34,905, and on May 31st, 1893, 38,666.

Mr. A. G. Gillingham was re-elected as a director, and the election of Mr. John Annan as director was confirmed.

The meeting concluded with the usual vote of thanks to the chairman.

Central London Railway Company.

A SPECIAL general meeting of the proprietors of the Central London Railway Company was held on Tuesday at 30, St. Swithin's Lane, E.C., for the purpose of submitting "An Act for incorporating the Waterloo and City Railway Company, and for empowering them to construct an underground railway from near Waterloo Station to Mansion House, City, and for other purposes." Mr. F. A. Lucas presided, and said the meeting was convened in accordance with the standing orders of the House of Lords. The Waterloo and City Bill contained a clause enabling both companies to enter into a working agreement, and it was therefore necessary that the proprietors should formally approve the Bill. The Chairman concluded by moving a formal resolution approving of the Bill, subject to such additions, alterations, and variations as Parliament might think fit to make therein.

The resolution was seconded by Mr. HAMILTON SMITH, and carried unanimously without discussion.

West African Telegraph Company.

THE report of the directors for the year ended December 31st last shows that the revenue amounted to £60,923, against which £20,019 is charged for ordinary expenses, £13,964 for expenditure relating to repairs of cables, &c., and £802 for income tax, leaving a balance of £26,137. From this amount is deducted £23,727 (being for interest on debentures £13,060, and for sinking fund £10,667), leaving a balance of £2,410 to be carried forward. The large increase in the expenditure for repairs of cables is mainly due to the breaks that have occurred in the Sao Thomé-Loanda section, off the river Congo. This cable is now being diverted beyond the influence of the currents caused by the river. There has been a further loss on exchange of £8,044 for the year, which is chiefly owing to the continued depreciation of Portuguese currency, and negotiations are still being carried on with a view, as far as possible, to minimise the loss in future transactions.

Norwich Electricity Company, Limited.

THE second ordinary general meeting of this company was held on Saturday, June 17th, at the office in Queen Street, the chairman, Mr. F. W. Harmer, presiding.

The SECRETARY having read the notice convening the meeting, the following report of the directors was unanimously adopted:—

"The directors have much pleasure in informing the shareholders of the Norwich Electricity Company, Limited, that their works are rapidly approaching completion, and it is hoped they will be in operation within two months from the present time. After very much enquiry as to the respective merits of the different systems of electric lighting, and their adaptability to the conditions of Norwich, including personal visits to many of the stations which are at work successfully in different parts of the country, the directors finally arranged with Messrs. Laurence, Scott & Co., of this city, to carry out, on advantageous terms, plans which they had prepared with the assistance of Prof. Henry Robinson, C.E., the consulting engineer of the St. Pancras Vestry. The directors have purchased, on favourable conditions, an admirable site for their central station, near Duke's Palace Bridge, which fulfils all the conditions necessary for the economical production and distribution of electrical energy, and is large enough to give ample room for future expansion. Buildings have been erected on this site, and the necessary machinery is now being laid down in them. In selecting and purchasing this machinery, and in carrying out the works generally, the directors have endeavoured to take advantage of the experience of towns which were earlier in the field, and they hope, as a result of this, that when it is completed the shareholders will find themselves in possession of apparatus of the newest and most efficient kind. The directors believe the work of the contracting engineers has been carried out in a careful and substantial manner. They think that it will prove to have been advantageous to the company, especially with regard to the future working of the scheme, that they should have been able to employ a local firm. Messrs. Laurence, Scott & Co., having been for some years supplying electric light and power in the city, the directors thought it desirable in the interests of the company to arrange with them to continue to do so until the company was ready to start working. The directors have appointed Mr. F. M. Long their clerk of the works, and he has performed his duties to their satisfaction. They have themselves given much personal attention not only to the affairs of the company generally, but to the carrying out of the works; but as their principal desire is to make the company a success, they do not ask the shareholders to vote them any remuneration for the past two years. The experience of other towns shows that as soon as electrical stations are started the demand for light, &c., rapidly increases, and the enquiries which the directors are now receiving are such that they believe that their present machinery will not long be sufficient to supply the needs of their customers. They propose, therefore, to offer to the public a portion of the shares at present unissued, and they will be glad to receive, from the shareholders or their friends, applications for any further shares they may wish to take up. Electric lighting having proved to be a profitable business elsewhere, they have no doubt it can be made so in Norwich. The directors who retire by rotation are the Mayor of Norwich (Mr. A. R. Chamberlin), and Mr. I. B. Coaks, and they offer themselves for re-election."

The CHAIRMAN said the board were glad to announce the near completion of the works, which should be in full working order in a short time. The directors did not apologise to the shareholders for not having been ready to start before, because it was a case where, had they taken more haste, it would certainly have resulted in less speed. The directors had, in fact, their trade to learn, and they determined before they spent the money which had been entrusted to them, to make every enquiry that was possible, in order to ascertain, from the experience of other places, the best way of dealing with the difficult problem they had to solve. That it was a difficult one was shown by the fact that the corporation, containing some of the shrewdest men in the city, many of whom were anxious to acquire both the gas and waterworks, had determined, after very careful consideration, to leave the question of electric lighting alone. There was no such general consensus of opinion among electricians, either as to the best principle of producing and distributing electricity, or as to the most suitable machinery and apparatus to use for that purpose that would have justified the directors in proceeding otherwise than with the greatest caution. Whether or not they had been successful, time alone would show, but he could say without any hesitation, both for himself and his colleagues, they had left no stone unturned in their efforts to make the company a success. There was hardly any detail to which they had not given the closest personal attention, and they had taken no important step without getting the best scientific advice within their reach. The shareholders would notice, by reference to the balance-sheet, that this had been done at a very small cost; there had been hardly any expense incurred which, in the opinion of the Government auditor, could not be fairly charged to capital account. The arrangement which the directors had made with Messrs. Laurence, Scott, and Co., to carry on and develop the business of electric lighting in the city until the company was ready to start, had worked well. Since the beginning of the present year, the number of lamps installed had nearly doubled, and thus the company would commence its operations with a guaranteed income for the first year. Although the work of the last few years had cost them an immense amount of labour and anxiety, the directors did not at present ask for any remuneration, as their great desire was to make the company a success; but when it became so, as he had no doubt it would before long, they felt they might leave it to the shareholders to vote them such a sum as they might think they had earned. Before putting the resolution, the chairman said the directors would be glad to hear any remarks, or give any information to any gentleman present.

Mr. COAKS pointed out that if the demand for electric light went on increasing at the present rate the company would soon require new machinery, and, consequently, more capital. The directors were confident that the company could be made to pay, they had put their own money into it, and they trusted their fellow-citizens would give them liberal support.

Mr. BARWELL said that he had heard several complaints that the company was proposing to charge double price for the light at those times of the day when it was most wanted.

The CHAIRMAN said that such persons took a most unfair view of the matter. The normal price—he might say the fair price for electric light in Norwich—fixed indeed by the Board of Trade, was 8d. per unit, and he doubted whether it could be produced here, at any rate at first, at less than that figure. The directors of the Norwich company had, however, at the suggestion of Messrs. Laurence, Scott and Co., determined to try an experiment, which, he believed, had not been adopted elsewhere. They proposed to charge half-price to any person who desired to take it after the general demand for light had ceased. One of the great expenses of electric lighting was that of getting up steam; when the steam was once got up it cost comparatively little to run the machinery an extra hour, and they were willing that all their customers should share in the advantage of getting in this way light at a reduced price which it would cost them less to produce.

Mr. STEWARD, in proposing the re-election of the Mayor and Mr. Coaks, said he regretted the directors had not asked for any remuneration for the labour they had taken in the starting of the company and erection of the works.

Mr. BARWELL seconded, and it was carried unanimously.

Mr. James Mottram was also re-elected auditor, on the motion of Mr. LAURENCE, seconded by Mr. CANNELL.

We understand that at a subsequent meeting of the directors an application from the trustees of the Methodist chapel in Chapel Field Road, to be allowed to have the use of the electric light on Sundays at the half-price rate was considered, and it was determined, in order to meet their views, to charge the reduced rate to all customers after seven o'clock instead of eight o'clock, on Sundays only.

Anglo-Portuguese Telephone Company.—Coupons No. 11 of the first mortgage and No. 6 of the second mortgage debentures will be paid, less income-tax, by Parr's Banking Company and the Alliance Bank, Bartholomew Lane, on and after the 1st prox.

Eastern Extension, Australasia and China Telegraph Company.—The directors have declared an interim dividend for the quarter ended March 31st last of 2s. 6d. per share, free of income tax, payable on the 15th prox. The share register will be closed from the 7th to the 14th prox., both days included.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending June 25th, 1893, amounted to £765; week ending June 26th, 1892, £747; increase £18; total receipts for half-year, 1893, £21,799; corresponding period, 1892, £20,132; increase £1,667.

The Western and Brasilian Telegraph Company, Limited. The receipts for the week ending June 23rd, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brasilian Telegraph Company, Limited, were £2,476.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Issue.	Name.	Stock or Share.‡	Closing Quotation June 22nd.	Closing Quotation, June 28th.	Business done during week ended June 28th, 1893. Highest.	Lowest.
195,100£	African Direct Telegraph, Ltd., 4 p. c., Deb. Regd. and to Bearer	100	101 —104	101 —104	...	...
1,134,640£	Anglo-American Telegraph, Limited	Stock	51 — 52	51 — 52	...	...
2,932,680£	Do. do. 6 p. c. Preferred	Stock	94½ — 95½	94½ — 95½	95	93
2,876,140£	Do. do. Deferred	Stock	10⅞ — 11¼	10½ — 11	11	10½
130,000	Brazilian Submarine Telegraph, Limited	10	11⅜ — 12½	12 — 12½	12¼	12⅛
36,400£	Do. do. 5 p. c. Bonds	100	100 —103	100 —103	...	...
75,000£	Do. do. 5 p. c., 2nd Series, repayable in June, 1906 ...	100	107 —111	107 —111	...	...
77,978	Brush Electrical Engineering Ordinary, Nos. 1 to 63,416	3	3 — 3¼	3 — 3¼	3 1/16	...
75,000	Do. do. Non cum. 6 p. c. Preference, Nos. 1 to 63,416	2	2⅛ — 2⅜	2⅛ — 2⅜	2 3/16	...
125,000£	Do. do. 4½ per cent. Debenture Stock	Stock	107 —109	107 —109	109	...
44,000	Chili Telephone, Limited, Nos. 1 to 40,000	5	2 — 3	2 — 3	...	...
630,000£	City and South London Railway	Stock	37 — 39	36 — 38	...	...
40,000	City of London Elec. Lighting Co., Ltd., Ord. 40,001-80,000 ...	10	11½ — 12	11½ — 12	...	...
20,000	Do. do. 6 p. c. Cum. Pref., Nos. 1 to 20,000	10	12⅛ — 12⅜	12⅛ — 12⅜	12⅜	12⅛
$7,716,000	Commercial Cable, Capital Stock	$100	138 —142 xd	138 —142	...	...
224,850	Consolidated Telephone Construction and Maintenance, Limited ...	14/-	3/16 — 5/16 xd	1/8 — 1/4	...	...
20,000	Crompton & Co., Ltd, 7 p. c. Cum. Pref. Shares, Nos. 1 to 20,000	5	5¼ — 5⅜	5⅛ — 5⅜	...	...
16,000	Cuba Telegraph, Limited	10	11½ — 12½	11½ — 12½	...	...
6,000	Do. do. 10 p. c. Preference	10	18½ — 19½	18½ — 19½	...	...
12,931	Direct Spanish Telegraph, Limited, ... (£4 only paid)	5	2½ — 3½	2½ — 3½	...	...
6,000	Do. do. 10 p. c. Preference	5	9 — 10	9 — 10	...	...
60,710	Direct United States Cable, Limited, 1877	20	11⅞ — 12½	11⅞ — 12½	12	11 13/16
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	15 — 15¼	15 — 15⅛	15¼	15
70,000	Do. 6 p. c. Preference	10	16¾ — 17¼	16½ — 17	16¼	...
105,900£	Do. 5 p. c. Debs. (1879 issue), repay. August, 1899	100	108 —111	108 —111	...	...
1,294,100£	Do. 4 p. c. Mortgage Debenture Stock	Stock	112 —115	112 —115	114½	113½
250,000	Eastern Extension, Australasia and China Telegraph, Limited ...	10	15⅝ — 15¾	15⅝ — 16	15 13/16	15⅝
70,600£	{ Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326 }	100	104 —107	104 —107	...	...
250,200£	Do. do. Bearer Nos. 1050—3,975 and 4,327—6,400 ...	100	104 —107	104 —107	...	...
320,000£	Do. 4 p. c. Debenture Stock	Stock	113 —116	113 —116	114	...
108,700£	{ Eastern and South African Telegraph, Ltd., 5 p. c. Mort. Deb. 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343 }	100	103 —106	103 —106	103⅞	...
146,800£	Do. do. do. to bearer, Nos. 2,344 to 5,500	...	103 —106	103 —106	...	...
300,000£	Do. do. 4 p. c. Mort. Debs. Nos. 1 to 2016, red. 1909	100	102 —105	102 —105	104½	104
49,900	Electric Construction, Limited, Nos. 101 to 45,100	10	1⅞ — 2¼	1½ — 2	2¼	1 15/16
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	... ...	... ...	...	...
100,000	Elmore's French Patent Copper Depositing Co., Ltd, Nos. 1 to 66,750	2	3/16 — 1/4	3/16 — 1/4	...	...
91,195	Elmore's Patent Copper Depositing, Limited., Nos. 1 to 70,000 ...	2	3/16 — 1/4	3/16 — 1/4	...	...
67,385	Elmore's Wire Mfg., Ltd., Nos. 1 to 67,385, issued at 1 p.m., all pd.	2	3/16 — 1/4	3/16 — 1/4	...	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300 ... (£4 10s. only paid)	5	1 — 2	1 — 2	...	...
180,227	Globe Telegraph and Trust, Limited	10	9¾ — 10	9¾ — 10	10	9 15/16
160,042	Do. do. 6 p. c. Preference	10	15⅝ — 15⅞	15⅝ — 15⅞	15⅞	15⅝
150,000	Great Northern Tel. Company of Copenhagen	10	19¾ — 20¼	19¾ — 20¼	20¼	20 1/16
200,000£	Do. do. 5 p. c. Debs. (issue of 1883) ...	100	105 —108	105 —108	...	...
12,134£	Greenwood and Batley, Ltd., Ordinary, Nos. 4667 to 14,000 ...	10	4½ — 5⅛	4½ — 5⅛	...	...
9,600£	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	6⅛ — 7⅛	6⅛ — 7⅛	...	...
50,000	India-Rubber, Gutta Percha and Telegraph Works, Limited ..	10	22½ — 23½	22½ — 23½	23 7/16	23 1/16
200,000£	Do. do. 4½ p. c., Deb., 1896	100	102 —104	102 —104	...	...
17,000	Indo-European Telegraph, Limited	25	39 — 42	39 — 42	41¼	39½
11,334	International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000	10	2½ — 3½	2½ — 3½	...	...
30,000	†Liverpool Electric Supply, £3 10s. paid	5	4 5/16 — 4 7/16	4 5/16 — 4 7/16	4 7/16	4 1/16
10,000	Do. do. fully paid	5	6⅜ — 6⅝	6⅛ — 6¼	6⅛	5⅞
37,548	London Platino-Brazilian Telegraph, Limited	10	4 — 6	4 — 6	...	...
100,000£	Do. do. do. 6 p. c. Debentures	100	107 —110	107 —110	...	...
49,900	*Metropolitan Electric Supply, Ltd., Nos. 6,101 to 50,000 (£9 paid)	10	6 — 6¼	6 — 6¼	...	...
50,000£	Do. 5 p.c. debentures, 1 to 5,000 in bonds of £10, £20, £40	...	102 —105	102 —105	...	...
15,000	Monte Video Telephone Co., Ord., Nos. 1 to 15,000 fully paid ...	5	1¼ — 2½	1½ — 2½	...	...
28,000	Do. do. 6 p. c. Pref., Nos. 1 to 28,000 fully paid	5	3 — 4	3 — 4	...	...
458,867	National Telephone, Limited, Nos. 1. to 438,984	5	5⅛ — 5⅜	5⅛ — 5⅜	5⅜	5 1/16
15,000	Do. 6 p. c. Cum., 1st Preference	10	14¾ — 15½	14¾ — 15¼	14 15/16	14 13/16
15,000	Do. 6. p. c. Cum. 2nd Preference	10	14½ — 14¾	14½ — 14¾	...	...
90,950	Do. 5 p. c. Non-cum. 3rd Pref., Nos. 1 to 90,950 ...	5	5⅜ — 5⅝	5⅜ — 5⅝	5 1/16	5 1/16
726,477£	Do. 4½ p.c. Deb. Stock Prov. Certs. fully paid ...	...	113 —117	113 —117	116½	115½
48,800£	New Telephone, Limited, Nos. 25,901 to 74,700 ... (£2 paid)	10	... ...	... ...	...	...
6,451	Notting Hill Electric Lighting Company, Limited, fully paid ...	10	5 — 6	5 — 6	...	...
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11s. only paid)	1	3/16 — 1/4	3/16 — 1/4	...	...
100,000£	Pacific and European Tel., Ltd., 4 p. c. Guar. Debs., Nos. 1 to 1,000	100	101 —104	101 —104	...	...
11,802	Reuter's Limited	8	5 — 6 xd	5 — 6	...	...
18,680	St. James's & Pall Mall Electric Light Co., Ltd., Ord., 101—18,780	5	7½ — 7¾	7½ — 7¾	...	...
20,000	Do. do. 7 per cent. pref., Nos. 20,081 to 40,080	5	8 — 8½	7¼ — 8¼	7⅞	...
3,381	Submarine Cables Trust	Cert.	120 —125	120 —125	...	...
78,949	Swan United Electric Light, Limited ... ... (£3½ only paid)	5	2 — 2⅛ xd	2 — 2⅛	2⅛	2⅛
37,350	Telegraph Construction and Maintenance, Limited	12	33 — 35	34 — 36	35	34
150,000£	Do do. do. 5 p. c. Bonds, red. 1894	100	103 —106	103 —106	...	...
58,000	United River Plate Telephone, Limited	5	2½ — 3	2½ — 3	...	...
146,370£	Do. do. 5 p. c. Debenture Stock ...	Stock	90 —100	90 — 100	...	...
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	5⅛ — 6⅛	5½ — 6½	...	...
260,900£	Do. do. do. 5 p. c. Debentures	100	99 —102	99 —102	...	...
30,000	West Coast of America Telegraph, Limited	10	3 — 4	3 — 4	...	...
150,000£	Do. do. do. 8 p. c. Debs., repayable 1902 ...	100	103 —107	103 —107	...	...
64,242	Western and Brazilian Telegraph, Limited	15	7¼ — 7⅜	7¼ — 7⅜	...	...
33,129	Do. do. do. 5 p. c. Cum. Preferred	7½	6 — 6½	6 — 6½	6½	...
33,129	Do. do. do. 5 p. c. Deferred	7½	1½ — 2	1½ — 2	1⅞	...
178,200£	Do. do. do. 6 p. c. Debentures "A," 1910 ...	100	106 —109	106 —109	...	...
222,700£	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	106 —109	106 —109	...	...
88,321	West India and Panama Telegraph, Limited	10	1½ — 1⅝	1½ — 1⅝	...	...
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	10⅜ — 11¼	10⅜ — 11¼	...	...
4,669	Do. do do. 6 p. c. 2nd Preference ...	10	9½ — 10½	9½ — 10½	...	...
80,000£	Do. do. 5 per cent debentures (1917) No. 1 to 1,000	100	108 —111	108 —111	109	...
$1,214,000	Western Union of U.S. Tel., 7 p. c. 1st Mortgage (Building) Bonds	$1,000	120 —125	120 —125	...	...
169,000£	Do. do. 6 p. c. Sterling Bonds	100	100 —103	100 —103	...	...
59,900	*Westminster Electric Supply Corp., Ord., Nos. 101 to 42,953 ...	5	5¼ — 5⅜	5¼ — 5⅜	5⅛	...

* Subject to Founders' Shares. † Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED:—Birmingham Electric Supply Company, Ordinary of £5 (fully paid), 5⅛—5⅜.—Brush Company 4½ per cent. Debenture stock, issued at 1 per cent. premium, 100—103.—Electric and General Investment, shares of £5 (£1 paid), 1½—2¼.—Founders' shares, 200—225.—Electric Construction Corporation, 6 per cent. Debentures, 95—98.—Electricity Supply Corporation, Ordinary of £5, 5—5¼.—House to House Company (£5 paid) 1¼—2¼.—Do. 7 per cent. Preference of £5, 5—5¼.—Do. 6 per cent. Debentures of £100, 97—102.—Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid), 5⅜—5⅝, 1st Preference Cumulative 6 per cent., £5 (fully paid), 6—6¼.—Liverpool Electric Supply Shares of £5 (fully paid), 6⅛—6⅜.—Manchester, Edison and Swan Company, 49 (£1 paid), ⅛—¼.—Queen Anne's Mansions Lighting and Heating 6 per cent. £10 Debentures, 101—103. Bank rate of discount, 2½ per cent. (June 15th, 1893).

ELECTRIC LIGHTING IN SPAIN.

WE are indebted to Messrs. Siemens & Halske, of Berlin, for the following information :—

The two small towns, Elgobar and Elbar, in the Spanish province of Viscaya, will shortly be supplied with electric current for lighting and for the transmission of power. The necessary working power will be furnished by the water of the river Dora. A newly erected system of dams supplies an available fall of 8·5 metres and 300 H.P. A "Hercules turbine" of 130 H.P., at 200 revolutions per minute, will be shortly set up by the firm of Singran-frères, of Epinal, and used for the direct propulsion of a rotatory current dynamo for 80,000 watts, by the firm of Siemens & Halske, of Berlin. The exciting machine also will be directly connected with the vertical shaft of the turbine.

The current produced by the dynamo has a tension of 120 volts, which is increased to 50,000 volts by means of rotatory transformers. Naked wires supported upon oil insulators serve to convey the electric energy to the towns at the respective distances of 1½ and 4½ kilometres, where the current is brought by a series of secondary transformers to the working tension of 120 volts and conveyed to the distributing mains.

Elgobar, the smaller of the two towns, contemplates chiefly electric lighting. There are here arranged 80 glow lamps for street lighting and about 140 for private consumption. In the more industrial town, Elbar, the demand for electric working power takes the first rank. Numerous locksmiths and manufacturers of weapons have applied for the supply of electric power, and the firm Siemens & Halske have already received orders for a considerable number of electromotors for from 1 to 25 H.P. As 120 glow lamps are required for street lighting, and about 400 for private use, it may be expected that the completion of the central station will shortly be required.

The entire installation is a private undertaking of the owner of the water-power, and is executed on his account by Sr. Ermanno Schilling, of Madrid, the general representative in Spain of the firm Siemens & Halske, who supply the machines and apparatus.

OIL v. COAL AS FUEL AT CHICAGO.

AN interesting periodical, called the *World's Fair Electrical Engineering*, has recently come into existence, and devotes itself to the interests of electrical and cognate objects of interest at the Chicago Exhibition. A recent number contains a description of the arrangements for burning oil as fuel under the boilers. It is assumed that three barrels of oil of 42 gallons each equal a ton of the best bituminous coal, and that if an inferior quality of coal were used, the thermal equivalent of one ton would be found in two barrels of oil. It is further anticipated that one fireman would be able to do the work ordinarily required of five or six. A contract has been entered into to have the oil necessary for generating steam within the ground at a cost not exceeding 72½ cents. per barrel of 42 gallons. (On the above assumptions this is practically equivalent to the best lump bituminous coal at 18s. per ton, or to ordinary coal at 12s. per ton.) The oil supply will be taken through 6-inch mains from the main system of the Standard Oil Company, and will have a daily delivery capacity of 1,000,000 gallons of oil.

The following is a description of the plant :

The storage reservoir and necessary pump house is located near the shore of the lake, some 3,200 feet to to the south-east of the power plant. The reservoir consists of 8 cylindrical tanks made of $\frac{3}{16}$-inch steel throughout, and are nominally 25 feet in length and 8 feet in diameter, and the actual average capacity of each is 9,370 gallons, making a total containing capacity of 74,960 gallons of oil, an amount of fuel sufficient to develop 39,340 horse-power hours when consumed under the type of boilers installed in the power plant.

These receiving tanks rest within an air-tight vault having a 15-inch floor of concrete, side walls of sewer brick laid in cement, and a roof of heavy "I" beams, with brick arches laid in cement springing from one beam to the adjoining one. The structure is placed on a level with the datum line, 5 feet below grade, and rises from thence to a height of 12 feet, while over all a foot of rich loam has been placed, and the whole embanked and sodded, giving it the appearance of a symmetrical grass-covered mound. The interior of the vault is divided into six separate compartments, having division walls of sewer brick laid in cement, each compartment holding two tanks supported on brick saddle walls, and beneath each compartment is a sump 3 feet in depth, containing a steam syphon for ejecting any water that may accumulate therein. Separating each pair of tanks by an 18-inch wall is a preventative against total loss should the oil in any one compartment become ignited through accident or carelessness, a contingency not liable to occur in an air-tight vault. With the aid of flanges, pipes were joined to each tank and then connected to suitable headers that extend through the vault, pass underground, and into the pumping station located 30 feet distant. These pipes include a 6-inch "outflow" line in head of tank near bottom, a 6-inch "overflow" pipe in head near top, a 4-inch "inflow" pipe in top of tank near head, a 2-inch pipe required in connection with the indicating apparatus that shows the amount of oil in the tanks, and two pipes of 1 inch diameter connected to steam coils extending six times the entire length of tank provided, for heating the oil in cold weather. The connecting headers are respectively : Two of 6 inches each for the "inflow," one of 6 inches for the "outflow," two of 9 inches for the "overflow," and two of 2 inches each for steam supply.

The machinery for the distribution of the oil to the various batteries of boilers is located in the solidly constructed brick pumping station, 30 feet to the east of the oil vault, and was specially designed and built for this plant. Within this pumping station are two brass-fitted duplex oil pumps, 8 by 8½ by 10, each having a total pumping capacity of 400 gallons a minute, that are operated by steam supplied from two 40 horse-power vertical boilers equipped with oil burners ; a vertical feed-water heater ; a 4 by 6 duplex feed-water pump ; and a Jenney incandescent dynamo, the current from which illuminates the station, and having portable lamps for inspection services ; while above the station rises a standpipe, 30 inches in diameter and 35 feet high, built of seven 60-inch rings of $\frac{3}{16}$-inch steel, erected with the object of maintaining a uniform pressure on the boiler supply lines. And as a precautionary measure, a 9-inch pipe extends outward for 2 feet from near the top of this standpipe and thence to the ground, and is designed to serve as an overflow pipe.

The big pumps draw the oil from the tanks and force it upward till it flows into the standpipe, from whence it passes into a 5-inch pipe that is joined to the standpipe near its base. This 5-inch pipe is boxed in with and paralleled by a 2-inch steam pipe, the heat from which will keep the oil limpid in cold weather. Both pipes are snugly packed in a casing made of 2-inch lumber, and box and pipes extend in a direct line to the centre of the main boiler house, 3,200 feet distant, where branch and lateral piping conveys the oil to the boilers.

One feature in this interesting installation is that all the important valves are electric valves, and are so arranged that not one unit of energy will have to be unnecessarily expended. For instance, if the demand on the boiler line is only for 1,000 horse-power per hour, the machinery in the pumping station will automatically adjust itself to delivering but the requisite quantity, while the starting up of a dozen additional boilers necessitating an increase to the extent of, say, 20,000 horse-power in oil, will be as quickly indicated at the pumping station, and automatically responded to by an increased speed and pressure in the machinery and an increased flow of oil, the pumps automatically slacking or decreasing their oil circulating power as the demands require, in response to the action of an electric float in the standpipe, which opens or closes the valves on a variance of 4 inches in the height of the column of oil.

The burners under the boilers are also connected electrically with a pressure gauge located on the boiler, so that any rise or fall of the pressure will open and close the burner. The feed water pump supplying the boilers with water is connected in the same way, and the same impulse is felt throughout and responded to by all the machinery. Then, as an additional precautionary measure, each machine is

provided with a high and low electric alarm that instantly notifies the engineer of changes in pressure.

The tanks will be filled whenever necessary, and as occasion arises a message will be sent to the relay station at Whiting, over a special wire, notifying the chief engineer to start the big pumps, when the oil will begin to flow. The quantity placed in each tank is shown by a steel tape indicator, and the quantity of oil used determined by means of an outage table carefully prepared for this purpose, and calculated on a scale for each fall of one-fourth of an inch.

An important precautionary measure for use in the event of the Whiting pipe line being temporarily disabled, includes a line of 5-inch pipe 150 feet in length, that extends along the railroad siding 100 feet distant. This line of piping is provided with six 2½-inch nozzles to be connected with tank cars, and the oil can then be pumped into the receiving tanks or the standpipe till the main line is again in order.

THE SUPPLY COMPANIES' RULES FOR THE WIRING OF HOUSES.

IT is of the utmost importance to a supply company that the house to which it is to supply current should be wired in such a manner that the possibility of accident is obviated. With this end in view, the supply companies have for the most part formulated rules of their own which must be observed by contractors wiring houses.

We propose in this, and following issues, to publish the rules of the principal supply companies, in the hope that they may be of use to the many local authorities who are about to commence the supply of electricity.

We will take first the rules of the companies mostly associated with the alternating current.

THE LONDON ELECTRIC SUPPLY CORPORATION

rather issues its rules as suggestion than otherwise, for they specifically state they will take no responsibility with respect to house wiring; but, of course, current would not be supplied to any house of which the insulation was lower than the specified standard.

The corporation strongly impresses on its customers the importance of having the work of installation done by thoroughly competent contractors, and these suggestions are issued only as a guide which may be useful in directing their operations.

CONDUCTORS.

Copper.—In all conductors the copper should be tinned and of such sectional area that the current they supply shall not exceed 1,000 ampères per square inch.

Insulation.—All fixed conductors should be covered with at least one coating of pure rubber, and one of vulcanised rubber of approved thickness, and mechanically protected with some such covering as braided hemp, which must be rendered impervious to moisture.

Stranded.—All conductors whose sectional area is larger than that of No. 18 B.W.G. should be stranded.

No conductor of a less area than No. 18 B.W.G. should be used, except in the case of wires enclosed in fittings, where No. 20 B.W.G. may be used.

CASING.

Wood Casing should be of American white wood or other equally good approved material, at least 1¾-inch across, and the fillet not less than a full ½-inch in any place, particularly in the mitres, where great care should be taken not to cut away the fillet.

All the lids should be firmly screwed and not nailed down.

Wire in Zinc or other Tubes.—Single conductors ought never to be encased in zinc or other metal tubes of a greater length than 6 feet.

Where there is absolute necessity for such mechanical protection, both conductors should be placed together in a tube large enough to prevent any abrasion of the insulation.

Lead-covered wires ought not to be used under any circumstances.

Open Wires.—Conductors placed on outside walls not in casing should be fixed on insulators, and placed not less than 6 inches apart anywhere.

Staples.—No conductors under any circumstances whatever should be fixed by means of staples.

SWITCHES.

All switches should be of the best make, and of such design that they cannot possibly remain in any intermediate position between "on" and "off," and have good endurable rubbing contacts. No metal in switches carrying current should be exposed.

No fuse and switch should be combined.

FUSES.

All fuses should be of some recognised pattern, and their cases should be made of porcelain, and mounted on teak bases independently fixed to the wall. No fuses mounted in combustible material should be used.

All fuse cases should be in easily accessible places, and all fuses be stamped with the current at which they will fuse, and be easily renewable.

All branches should be protected by double-pole fuses placed as near to the mains as possible.

Every cluster-fitting should be supplied with at least one double pole fuse.

Every lamp hung on a flexible cord should have a fuse in the ceiling rose, and the wires of the cord be separately drawn through holes in the rose before coming to the terminals.

FITTINGS.

No gas fittings should be wired under any circumstances whatever unless the same are efficiently insulated from the gas supply pipe.

DISTRIBUTION OF CIRCUITS.

The mains from the converter in all cases should be taken to distributing boards and there divided into as many small circuits as practicable. Every circuit should be controlled by a separate switch, and protected by a separate double-pole fuse.

No circuit leaving a distributing board should carry more than 75 ampères.

TESTING.

The corporation retain the right of refusal to supply current to any installation, before testing the insulation resistance of the circuits.

Installations not to have lower insulation resistance than the following:—

Up to 25 lamps ...	2 megohms.	Up to 100 lamps ...	·75 megohms.
„ 50 „ ...	1·25 „	„ 150 „ ...	·5 „

Installations failing this test will not be supplied with the current by the corporation.

The corporation will not continue the supply of current to any installation falling below the above tests, and which is so allowed to remain by the consumer.

No installation will, under any circumstances whatever, be turned on until the whole of the work is entirely finished.

In the event of any contractor adding to an existing installation without notice to the corporation, the whole of the installation will be cut off the circuit until the proper tests have been made.

SPECIAL APPARATUS.

All special apparatus, such as resistance and retarding coils, to be specially approved by the corporation.

RULES OF THE METROPOLITAN SUPPLY COMPANY.

CONDUCTORS.

Copper.—In every conductor the copper to be tinned and of such sectional area that the current in it shall not exceed 1,000 ampères per square inch, and of such area with respect to its length that the fall of pressure between the point where the company's wires are connected to the installation, and the furthest lamp therein shall not exceed two per cent.

Single conductors must never be encased in zinc or other metal tubes of a greater length than 2 feet.

Where there is absolute necessity for such mechanical protection, both conductors should be placed together in a tube large enough to prevent any abrasion of the insulation.

Lead covered wires must not be used under any circumstances.

No conductors, under any circumstances whatever to be fixed by means of staples.

All wiring work to be executed in accordance with the rules of the fire insurance companies.

SWITCHES AND FUSES.

Regulations as to switches similar to London Electric Supply Corporation.

Fuses.—It is very desirable that a cut-out be placed both in the positive and negative wires at every change of section, and this must be done as far as practical conditions will allow. A double pole fuse must be placed in the mains at a point of supply to be decided upon by the company, and the mains continued to reach the converter or other apparatus of the company.

GAS FITTINGS.

Same as London Electric Supply Corporation.

DISTRIBUTION OF CIRCUITS.

In the case of buildings requiring more than 50 ampères, the company will be glad to receive particulars of the circuits proposed.

TESTING AND INSPECTION.

No current will be supplied to any installation until the inspector of the company has tested the insulation resistance and certified that the work is satisfactory.

The company retains the right, without previous notice, to at any time cut off the supply to the whole or part of any installation if the insulation is defective, or the installation otherwise unsafe.

No current will, under any circumstances whatever, be turned on to any installation until the whole of the work is entirely finished.

In the event of any additional lights being turned on before they have been tested, and passed by an inspector of the company, the whole of the installation will be cut off the circuit until such tests have been made.

VOLTAGE.

In all ordinary cases the current will be supplied at a pressure of 50 or 100 volts, but other voltages can be supplied if special satisfactory reasons are given. The company strongly recommends the use of 50 volts.

ARC LAMPS.

Arc lamps must must be provided with suitable inductive choking coils, to be approved by the engineer of the company.

TRANSFORMERS, METERS, &c.

Transformers and main switches in the primary will be supplied and fixed by the company. The company will send an inspector to decide upon position of transformers and meter. The company will fix the meter and connect it to a bight, which must be left in the main for the purpose.

SPECIAL APPARATUS.

All special apparatus, such as resistance and impedance coils, to be submitted for the approval of the engineer of the company.

RULES OF THE HOUSE-TO-HOUSE COMPANY.

CONDUCTORS.

Every conductor throughout any installation must not have a current of more than 1,000 ampères per square inch sectional area, and the maximum loss shall not exceed 2 per cent. The main conductors to be brought to the converter, position of which is to be settled by the company's engineer, the usual place being the coal cellar, or some other suitable out-building.

All conductors must be stranded when larger than No. 14, B.W.G. No conductor is to be used of less sectional area than No. 18, B.W.G.

INSULATION.

All cables and conductors, except flexible cord, shall have an insulation of not less than 300 megohms per mile.

The minimum insulation tests passed by the company are as follows:—

10 lamps of any C.P.	...	5 megohms	
25	"	...	2	"
50	"	...	1·25	"
100	"	...	·75	"
150	"	...	·5	"

PROTECTION OF CONDUCTORS.

All conductors to be protected in well-seasoned wood casing, separated apart with a fillit of not less than ½ inch. All the cover of the casing to be screwed down. Under certain conditions wiring may be laid in metal pipes. Under no conditions are mains to be carried up the water course where hot and cold water pipes are fixed. If the casing is plastered into a wall it should be painted with some good oil paint. All casing should have its joints mitred into each other, and should be firmly fixed so that it does not take any strain. No gas fittings should be wired under any circumstances unless they are thoroughly insulated from the gas supply.

SWITCHES

to be of good manufacture, the metal portion being fixed to some non-combustible material, and to have a quick double break. The rubbing surface and section to be ample for the current it has to take.

FUSES.

All fuses to be fixed as near the mains as possible, when practicable. Fuses for groups of lights should be placed together at the point where the joint conductors divide. Not more than 6 8-C.P. lamps to be fixed on one fuse. All flexible to have a separate fuse for the length. The fuses to be fixed on some non-combustible insulating material; the fuse itself being of a metal whose melting point is low, and to be so fixed as to be easily accessible.

CEILING ROSES

are to be made of an incombustible insulating material, and should be so arranged as to allow fuses to be fixed in them.

LAMPHOLDERS.

All loop-lampholders are strongly objected to, bayonet socket lamps being preferred, with china or slate bases.

ARC LAMPS AND MOTORS.

Any arrangement for arc lamps and motors to be approved of by the company's engineer.

CONNECTING.

The company only undertakes to connect up as far as the converter. The main secondary fuse should be supplied by the contractor. The company supplies an alternating current of 10,000 alternations per minute at a pressure of 100 volts, unless specially desired otherwise.

TESTING.

The company holds itself the right of refusing to connect any house before tests are made and their engineer satisfied with the wiring.

(To be continued.)

PROCEEDINGS OF SOCIETIES.

The Société des Electriciens.

AT the last sitting of the Société des Electriciens, M. C. Rechniewski contributed a paper on the means of reducing the sparks at the brushes of dynamos. The writer summed up the causes of these sparks, and showed that in order to avoid them, we must have only slight variations in the flow, without too great excitation.

The Society has taken great interest in the propositions to be laid before the Congress of Electricians at Chicago by the American Institute. A committee, including Messrs. Raymond, Blondel, Hospitalier, Benoit, Violle, Guillaume, Pellat, &c., had been appointed to study these propositions. This committee has met and drawn up a report, which M. H. Pellat laid before the assembly. The contents of this report are as follows:—

1. The committee is of opinion that the decisions of previous congresses should not be altered, unless grave errors are discovered.
2. The termination *ance* should be adopted for designating magnitudes (resistance, conductance), and the termination *ity* for the properties of matter (resistibility, conductibility).
3. Neither the definition of the coefficient of self-induction, nor the terms *permeability* and magnetic susceptibility should be altered.
4. The name of *reluctance* should be given to the magnetic resistance.
5. The name of *reactance* should be given to the quantity, K, the square of which, K^2, added to the square of the resistance of a body, R^2 gives the apparent resistance of the body, $R^2 + K^2$ traversed by periodic currents.
6. The unit *quadrant* should be retained.
7. In the definition of the legal ohm, the mass of mercury should be taken into account in order to facilitate the determinations of the section.
8. For the standard ampère, we should refer to the instructions of the Board of Trade, in which we shall find the determination of the deposit of silver.
9. We shall not create a standard of conductibility, but for commercial purposes we can refer to the resistance of a mass of copper 1 kilogramme in weight and 100 mètres long.
10. The terms, *mono-*, *bi-*, *tri-phased*, are to be retained.
11. As regards symbols, they can only be discussed to any purpose before the congress, on account of the diversity of languages.

These various propositions were approved by the assembly.

M. Violle then presented his researches on the voltaic arc. He first established constancy in the brilliancy of the carbon with currents varying from 10 to 400 ampères, with the help of the spectro-photometer, and a photometer with interference fringes. Some photographs of carbons under various intensities had been taken, and M. Violle showed them before the Society. He then explained the theory which he holds of volatilisation at the positive pole, and described the experiments made by him with rods of carbon placed in the arc. In conclusion, M. Violle described the calorimetric method, by means of which he found the temperature of the arc to be 3,500°.

Royal Society.

MAGNETIC QUALITIES OF IRON. By J. A. EWING, M.A., F.R.S., Professor of Mechanism and Applied Mechanics in the University of Cambridge, and Miss HELEN G. KLAASSEN, Lecturer in Physics, Newnham College. Received June 7th, 1893. (Abstract.)

The paper describes a series of observations of magnetic quality in various specimens of sheet iron and iron wire. A principal object was to determine the amount of energy lost in consequence of magnetic hysteresis when the iron under examination was carried through cyclic magnetising processes between assigned limits of the magnetic induction, B. For this purpose, observations of the relation of the induction, B, to the magnetic force, H, were made, from which curves were drawn, and the area enclosed by the curves in cyclic magnetising processes was measured. Many such cycles were gone through in the case of each of the specimens, the limits between which B was reversed being varied step by step in successive cycles, to allow the relation of the energy expended, or of $\int H\,dI$ to B to be determined. The curves of B and H in these graded cycles are drawn in the paper, as well as curves showing the relation of $\int H\,dI$ to B and to H. Most of these experiments were made by the ballistic method, the specimens being in the form of rings. The iron examined was, for the most part, thin sheet metal or wire such as is used in the construction of transformer cores. The experiments show that there are marked differences in the values of $\int H\,dI$ in different specimens, some nominally soft iron requiring two, and even three times as much work to be spent in reversing its magnetism as is required in the best iron. They show, further, that great permeability does not necessarily imply small hysteresis losses. The order of merit in a group of samples is not the same when permeability is made the criterion of magnetic softness, as it is when the smallness of $\int H\,dI$ is made the criterion.

In connection with these results a formula proposed by Mr. C. P. Steinmetz ($\int H\,dI = c\,B^{1\cdot6}$)* to express the relation of the hysteresis losses to B, is discussed, and it is shown that although such a formula may serve fairly well as an approximate statement of the relation within those limits of B which are important in practice, it fails when applied to the more extreme portions of the curve.

The authors go on to describe a second group of experiments, in which direct measurements were made of the heat developed in magnetic reversals. The method consisted of using two rings, alike in all respects, with divided magnetising coils. One ring had its coils coupled, so that the two parts opposed each other, and the core was consequently not magnetised when a current passed. The other ring was active, and its coils (coupled inductively) were connected in series with the non-inductive coils of the inactive ring. Alternating currents were passed through both, and the active ring became heated by the effects of hysteresis and Foucault currents. To balance this a steady current was caused to flow in the core of the inactive ring, and the energy expended in the magnetic reversals of the active ring was found by measuring the energy which had to be expended in this current in order that the temperature of the two rings might continue equal. In some cases the rings used were miniature trans-

* *Trans.* American Inst. Electrical Engineers, Vol. 9, No. 1.

formers, and the test was applied to see whether the energy expended in magnetic reversals remained the same when the secondary of the transformer was closed as when it was open. This question had been raised by more than one experimentalist in relation to tests of the efficiency of transformers. The authors could not detect any difference in the amount of energy consumed in the core when the "load" was taken off or put on the secondary.

In a third group of experiments the magnetic curve tracer was used to examine certain features of the curves of magnetisation. This instrument, invented by one of the authors, draws curves which exhibit the relation of the magnetisation of given samples of iron or steel to the magnetising current. Amongst other points referred to in this connection is the time-lag in magnetisation, which is well shown by the curve-tracer, and the effects are compared of the same cycle of magnetic force gone through at various speeds. It is shown that in solid bars 1·9 cm. in diameter, especially in soft iron, remarkable evidences of time-lag are seen, even when the period of magnetic reversal is as long as 3 secs. The work spent per cycle is a maximum at a particular frequency, which in such bars is very low.

The fourth and last section of the paper relates to the molecular theory of magnetisation, and describes experiments made with groups of small pivoted magnets. It is shown that the behaviour of such groups, when exposed to the action of a variable magnetic field, presents striking points of resemblance to the behaviour of iron or steel under corresponding variations of magnetising force. Results are given which tend to confirm the theory.

The particulars of the observations are set out in about forty sheets of curves which accompany the paper.

AUSTRALIAN ELECTRICAL NEWS.

[FROM OUR OWN CORRESPONDENT.]

THE Legislative Assembly has had a fair share lately of electrical Bills before it lately; the Bill to enable the Municipality of Sydney to go in for electric lighting having come up for its second reading, and also the Australasian Rights Purchase Association's Bill, to enable it to utilise some of the waste water-power of the colony for supplying the City of Sydney and elsewhere with electric light and power. The City Bill unfortunately did not succeed in getting very far, owing to an adjournment. It met with more opposition than it did on the first reading, for some unknown reason, and latterly the papers have shown disapproval of some of its items; the opposition, however, seems principally to be against the introduction of the clause enabling the municipality to supply the private lighting as well as street lighting. The *Daily Telegraph*, in a leading article on the speculative spirit of corporations, after soundly rating some of the smaller municipalities for trying to raise loans for the purpose of, as they put it, going into business as a purveyor of gas in opposition to the company now supplying the residents with light, then proceed to take the City Council to task for doing the same thing, or attempting to do the same thing with electric lighting, and points out that it has no right to deal with anything but the public lighting of the streets. There was a very animated discussion on the Australasian Rights Purchase Bill, which is intended to empower the said company to divert water for mechanical power from the Colo and Grose rivers, and to construct and work plant for generating electricity, and transmitting it to Sydney. One member said he looked, according to his lights, on the projectors of the Bill as a number of pirates, as they had taken advantage of the knowledge and researches of others to make a profit for themselves, and stated that in February, 1892, four Sydney gentlemen applied for leases for dam sites on the rivers Colo and Grose, and in May, 1892, some Victorian gentlemen applied for sites just above those applied for by the Sydney syndicate. This bill was the outcome of the application by the Victorian syndicate, and it appeared to him that they had simply utilised the knowledge gained by the Sydney gentlemen. This was replied to to the effect that the Sydney syndicate referred to were really men employed by the Victorian syndicate, and the argument was carried on *ad infinitum*. After some mention of "lobbying," the Bill went through Committee finally with a little proviso tacked on to it that will have the effect of proving whether genuine business is meant; it is to the effect that a deposit of £5,000 will be required from the company, to be forfeited if they do not avail themselves of the privileges granted by this Bill, within a certain time. The Katoomba Municipal Council have also been discussing the question of raising a loan to provide gas works, which brought forth a strong protest from certain gentlemen who have been moving with regard to the establishment of an electric lighting company, who propose to avail themselves of the power derivable from the Katoomba Falls to generate electricity for distribution. Councils all round seem to be getting more or less involved in electric lighting or gas lighting matters. The Wellington, N.Z., *Post*, referring to a meeting of the local council, says:—Councillor Petherick is exercised in mind over the electric light. He says that our street lamps are not as brilliant as they ought to be, and its all on account of "the little thing inside" not being renewed often enough. Councillor Petherick is somewhat diffident on the subject of electricity, as he doesn't understand what he describes as "trade names." However, he has been consulting an expert, and is satisfied that what is wanted is a photometer (he called it a "portermeter," and an irreverent councillor wanted to know if it was related to "porter-gaff"). The photometer was to be carried round in the pocket of the city surveyor, who was to produce it whenever and wherever he saw an electric light.

NEW PATENTS—1893.

11,462. "Improvements in or relating to electrical conductors." J. H. HOLMES, T. HOLMES and J. B. ATHERTON. Dated June 12th.

11,464. "Improved galvanic electric belt or bandage." W. P. THOMPSON. (Communicated by H. T. Biermanns, Germany.) Dated June 12th. (*Complete.*)

11,516. "Improvements in alternate current dynamos." J. Y. JOHNSON. (Communicated by La Société l'Eclairage Electrique, France.) Dated June 12th.

11,517. "Improvements in dynamo-electric machines." J. Y. JOHNSON. (Communicated by La Société l'Eclairage Electrique, France.) Dated June 12th.

11,521. "Improvements in electric motors." P. M. JUSTICE, (Communicated by the Clyde Electric Motor Company, United States.) Dated June 12th.

11,557. "Automatic electric call recorder." W. J. CHIVERS. Dated June 13th.

11,567. "Electric lamp, gas, water or motive force meter." P. CADOT and A. CHARRON. Dated June 13th.

11,578. "A new or improved method of electrically welding metals." W. P. THOMPSON. (Communicated by C. L. Coffin, United States.) Dated June 13th. (*Complete.*)

11,579. "A new or improved method of, and apparatus for, electrically heating or welding metal." W. P. THOMPSON. (Communicated by C. L. Coffin, United States.) Dated June 13th. (*Complete.*)

11,596. "Improvements in secondary or storage batteries." W. MUIR. Dated June 13th.

11,608. "Improvements in electrical heaters." J. F. MCELROY. Dated June 13th. (*Complete.*)

11,609. "Improvements in electric switches." J. F. MCELROY. Dated June 13th. (*Complete.*)

11,610. "Improvements in apparatus employed in the evolution and collection of hydrogen and oxygen gases by electrolysis." C. J. YARNOLD. Dated June 13th.

11,649. "Improvements in apparatus for facilitating telephonic intercommunication." Sir C. S. FORBES, Bart. Dated June 13th.

11,716. "The 'preventum' crank and wire, and electric pull out bell-pull." C. PARKES. Dated June 14th.

11,717. "Improvements in coal plates, covers for cellars, electric light boxes, and like purposes." THE SAFETY TREAD SYNDICATE, LIMITED, J. MASON, and J. MASON. Dated June 14th.

11,728. "Improvements in switches for electric currents." E. F. MOY. Dated June 14th.

11,729. "Improvements in coin-freed machines for administering electric currents." P. REINER. Dated June 14th. (*Complete.*)

11,749. "Improvements in heating liquids by electricity." A. B. WOAKES. Dated June 14th.

11,759. "Improvements in or relating to electric bells." C. TURNBULL, Jun. Dated June 15th.

11,801. "Improved means and appliances connected with securing electric light fittings." C. N. RUSSELL. Dated June 15th.

11,819. "Improvements in electric railway trolleys." E. H. ALLEN. Dated June 15th. (*Complete.*) [Date applied for under Patents Act 1883, Sec. 103, November 16th, 1892, being date of application in United States.]

11,842. "Improvements connected with the insulation of electrical conductors." E. PAYNE. Dated June 16th.

11,890. "Improvements relating to telephones." P. RABBIDGE. Dated June 16th.

11,921. "Improvements in and relating to suspensory apparatus designed more especially for electric and other hanging lamps, but adapted for suspending and regulating the height of suspension of other articles." W. H. JOHNSON. Dated June 17th.

11,973. "Improvements in apparatus for electrolysis of water." SIEMENS BROS. & Co., LIMITED, and E. F. A. OBACH. Dated June 17th.

11,977. "Improvements in electrical search and signalling light apparatus." S. O. COWPER-COLES. Dated June 17th.

11,983. "Contact-plates or electrodes for forming and charging, or for alternately charging and discharging plates or elements to be used in voltaic batteries." D. G. FITZGERALD. Dated June 17th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1891.

15,749. "Improvements in electric arc lamps." W. H. AKESTER. Dated September 17th. Claims:—1. In an electric arc lamp, the combination of two carriers for the upper and lower carbons, connected through suitable rods or the like, by means of a flexible connection, a sprocket wheel or pulley loosely mounted upon its shaft over which the flexible connection passes, a spring for normally holding the sprocket wheel shaft in a given position, a collar upon the shaft located upon one side of the sprocket wheel, a screw thread upon the other end of the shaft, a nut loosely engaging the screw thread, a solenoid, an arm or projection from the nut, and a link connecting the core of the solenoid with such arm, substantially as shown and described and for the purpose stated. 2. In an electric arc lamp, a regulating device consisting of a shaft, a wheel mounted loosely there-

on, a spring or the like for normally retaining the shaft in a given position, a screw thread upon the shaft, a nut loosely engaging the screw thread and adapted to engage the wheel, means for causing the carbons to rise and fall by the rotation of the wheel, a solenoid and suitable connections from the core of the solenoid to the nut for causing the same to partially revolve with the rise or fall thereof, substantially as shown and described and for the purpose stated.

17,119. "Improvements in electrical switches." W. C. CHEESEWRIGHT. Dated October 8th. Claim:—That the switch is more compact and of shallower depth than switches hitherto manufactured. That its whole depth being not more than the plaster depth of any wall, it can consequently lie flush with such wall and so avoid disfigurement. Also that it is so secure in its action due to the locking of the lever, that it cannot by any but wilful means fail in its purpose.

17,809. "Improvements in or applicable to magnetic compasses or other instruments in which dials or movable indices are employed." T. G. H. NICHOLSON. Dated October 17th. The main object of the improvements is to provide luminous white or other dials which shall be durable and thoroughly efficient in action, the luminosity in the case of luminous dials being produced by any suitable luminous paint or paste, preferably of a light colour, so that the readings on the dial may be readily visible in daylight. 4 claims.

18,011. "Improvements in telephone switchboards." A. WHALLEY. Dated October 21st. Relates to an improvement in multiple metallic-circuit switchboards described in Specification Patent No. 3,276, 1890, for controlling wires with which an "earth" connection is made at subscribers' stations when disengaged. The object is to avoid the expense of providing a separate "earth" connection at each subscriber's station and to substitute a common "earth" connection at the exchange to which each pair of wires is joined so long as they remain free for a connection for conversation. 5 claims.

18,597. "Improvements in electrolysis." E. ANDREOLI. Dated October 28th. Refers to a process, and apparatus for decomposing by electrolysis, solutions of salts such as chlorides, sulphates, &c., and for separating efficiently, and economically the constituent parts of such compounds by means of porous conducting partitions acting as cathodes. The process applies also to two different inorganic, or organic solutions, each in a separate compartment, one of which combines by electrolysis with one of the constituent parts of the other solution, for instance by sending its alkali, and its hydrogen into the negative compartment to act on the solution, or inversely some constituent parts of the cathode compound may be sent by electrolysis into the solution of the positive compartment. 6 claims.

21,142. "Improvements in ceiling roses and wall plugs for electrical fittings." W. P. ADAMS. Dated December 4th. The object of the invention is to facilitate the attachment and removal of the fitting suspended from the ceiling rose. 3 claims.

21,849. "Improvements in armatures for dynamo-electric machines." B. S. PATERSON and J. B. FURNEAUX. Dated December 14th. Claims:—1. An armature for a dynamo-electric machine, wherein the sheet metal discs of which it is partly composed are each slotted radially, and formed with a central polygonal hole and with recesses at the sides of the hole, and are mounted upon a shaft of corresponding polygonal cross sectional shape formed with longitudinal grooves, the arrangement being such that when the discs are in place on the shaft, the recesses in the discs and the grooves in the shaft form longitudinal air passages that communicate with the radial air passages formed by the radial slots in the discs, so that air can circulate through such passages and channels when the armature is rotated, substantially as described. 2. The improved armature constructed substantially as described.

21,354. "Improvements in apparatus for measuring electric currents." H. ARON. Dated December 7th. Claims:—1. An apparatus for measuring alternating electric currents of different phases (multiphase currents), which consists in the combination with two systems of coils, each of which systems, either directly or indirectly, measures the product of the current of one feed conductor and that tension which exists between that conductor and a third conductor, of mechanical means, by which the difference of the two products is algebraically integrated or registered. 2. The combination with two measuring apparatus, each of which integrates or registers the product of the current of one feed conductor, and the tension existing between that and a third conductor, of a differential counter serving to mechanically subtract the inductions of the two measuring apparatus.

21,363. "An improved electric lift." I. PERAL. Dated December 7th. Relates to a lift actuated by an electro-motor instead of by the hydraulic machinery hitherto generally employed for this purpose; and possessing, further, the especial feature that persons making use of it may be transported to whatever floor of the building they may desire, on inserting a coin into an aperture or slot provided for the purpose.

21,766. "Improvements in apparatus for measuring the expenditure of electrical energy." S. SCHUCKERT and A. WACKER. Dated December 12th. In the improved apparatus the field windings of an electromotor are passed through by the current to be measured, while the armature is connected to points of constant potential. A damping device consists of a pair of electro-magnets in the vicinity of which rotates a copper disc, so that eddy currents are produced therein which damp the disc. 3 claims.

22,255. "Improvements in electric telephone transmitters." A. A. CAMPBELL SWINTON. Dated December 19th. Consists in arranging the electrodes with which the granules make contact, side by side horizontally in the same, or approximately the same plane, the carbon or other granules being distributed in a thin layer over the upper surfaces of the electrodes, so that the granules rest on the electrodes, merely by means of their own weight, and are not otherwise compressed or wedged together. 3 claims.

22,284. "An improved device for suspending electric cables or conductors." H. EDMUNDS. Dated December 21st. Consists of hook shaped pieces reversely placed so that the opening of the one is in an opposite direction to the opening of the other, and they between them form a loop as viewed from their sides. They are provided or formed with an eye or equivalent means by which they can be attached or connected to the support. 3 claims.

22,265. "Improvements relating to simultaneous telephony and telegraphy." J. STEPHEN and C. DAVIS. Dated December 19th. The inventors arrange that the operator shall transmit telegraphic signals by merely increasing or diminishing the resistance of the circuit, thus decreasing or increasing the current, instead of by making and breaking the circuit, or by reversing the current in the same; the change in resistance is effected by compressing a series of carbon discs. 2 claims.

22,304. "Improvements in means for use in, or in connection with, the conveyance of varying electric impulses, applicable to electric signalling for telegraphic, telephonic, or other purposes." S. P. THOMPSON. Dated December 21st. Consists in counterbalancing the effects of distributed capacity by applying distributed electromagnetic induction. This is effected, in some cases, by introducing at intervals into the lines or cables, or at more or less frequent points along the length of the lines or cables, organs possessing electromagnetic induction of amounts sufficient more or less completely to balance the distributed capacity, bearing in mind the average frequency of the electric impulses, whether telegraphic, telephonic, or other, which are to be transmitted. In other plans an electro-magnetic induction is distributed more or less uniformly along the lines or cables; such plans involving lines or cables of special construction. 5 claims.

22,316. "Improvements in electrical distribution and transformers therefor." J. D. F. ANDREWS. Dated December 21st. At any part of the mains of the three-wire system where current is to be taken off for local use or distribution, the inventor introduces the primary coil of a transformer connecting the plus wire to the middle wire, and the middle wire to the minus wire, and from the secondary coil of this transformer he takes the induced current for local use or distribution. 3 claims.

22,339. "Improvements in secondary batteries." N. WLADIMIROFF. Dated December 21st. Consists, chiefly, in making each of the electrodes of the same chemical nature on both sides, so that it acts simultaneously as a positive pole in one of the cells of the battery, and as a negative pole in the adjoining cell. 1 claim.

22,429. "Improved methods of varying the resistances of an electric circuit, specially applicable to musical instruments." P. E. SINGER. Dated December 23rd. The object of the invention is to enable a performer on a musical instrument actuated by electricity to vary the intensity of any note by increasing the pressure of the finger over the key operating it. The inventor places a receptacle containing a quantity of carbon powder in proximity to each key and it is arranged that depressing the key causes the powder to close the electric circuit which operates the instrument. Further pressure on the key compresses the powder, thereby lessening the resistance and so intensifying the sound. 1 claim.

22,404. "Improvements in the coupling of electric mains." H. W BOWDEN, A. GAY and R. HAMMOND. Dated December 22nd. The adjacent ends of the conductors are surrounded by a casing or covering of suitable insulating material, such as India-rubber, that can be secured to the insulating material on the conductors in such a manner as to effect a water-tight joint therewith. 3 claims.

22,507. "Improvements in supports for telephone receiving instruments." R. A. FRASER and G. F. R. KELSON. Dated December 24th. Consists essentially in the combination of a bracket adapted to be secured to a wall partition or other fixed agent with a sliding piece capable of being moved to and fro in, or on, the said bracket and with a holder for the telephone receiving instrument capable of being moved to and fro, and axially in or on a guide or guides on the sliding piece, sufficient stability being provided by spring or other suitable friction attachments. 2 claims.

22,542. "Improvements in devices for conducting electricity to lamps or the like on dining tables, or on other places, where it is desirable to employ concealed conductors." G. PHILLIPS and G. F. ROSE. Dated December 24th. According to this invention the conductors proper are formed preferably of flat strips of conductive material so that they present no objectionable projection when covered by a table cloth or the like, at the places where the lamp standards, or the like, are to be connected to the conductors, there are secured pieces of conductive material through which the conducting strips can be passed, these pieces being provided with conductive spikes, or the said pieces may be of non-conductive material and the spikes pass therethrough to make contact with the strips. The said spikes pass through a table cloth or the like when it is covered over the table or the like, and the conductive devices upon it. 1 claim.

22,695. "Improvements in apparatus for relieving electrical circuits from static charges of electricity." O. IMRAY. (Communicated from abroad by the Westinghouse Electric and Manufacturing Company, of America.) Dated December 29th. A metal discharge plate, connected to earth, is fixed in proximity to two revolving rings, on which bear the collecting brushes of the alternator, and pairs of metal plates respectively connected to those rings, are fixed at such points of the circumference that, as the armature revolves, each presents itself to the fixed metal plate at the moment when the current generated by the machine is being alternated-and passing the zero point of electromotive force. 1 claim.

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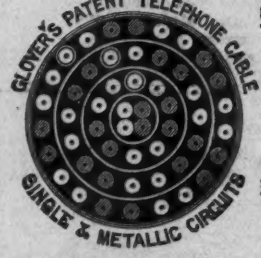

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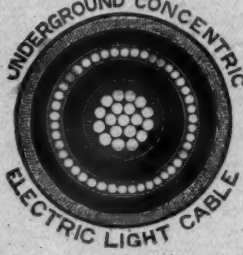

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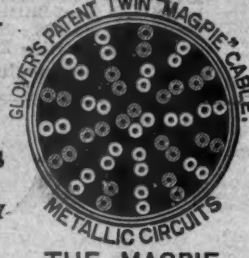

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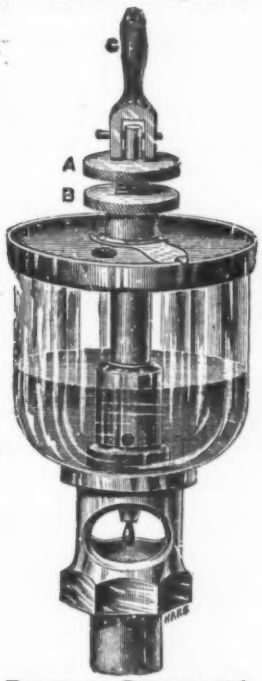

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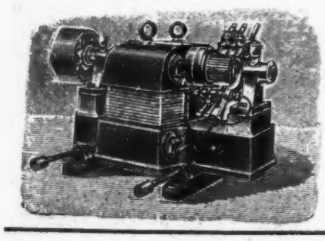

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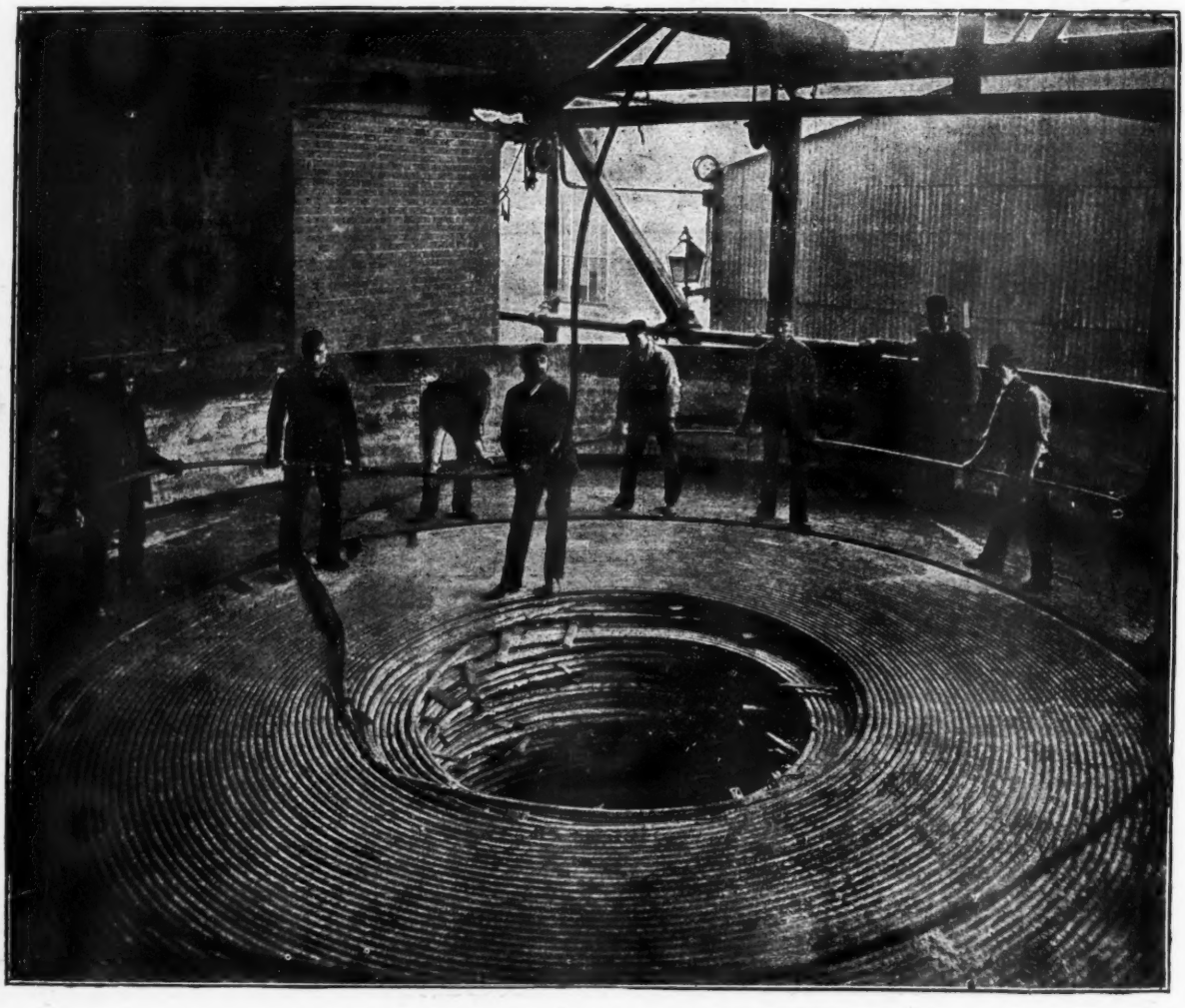

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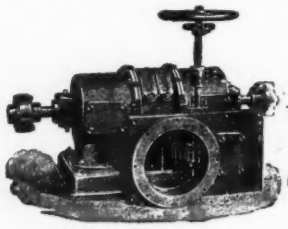
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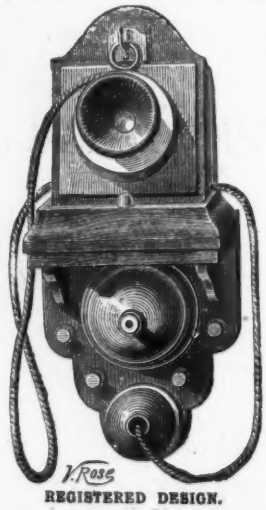
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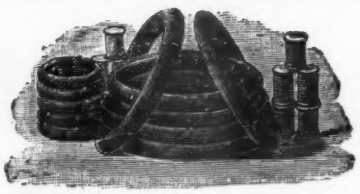

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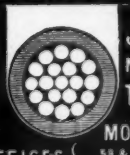

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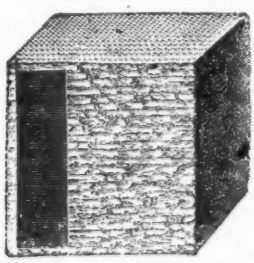

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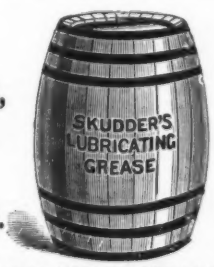

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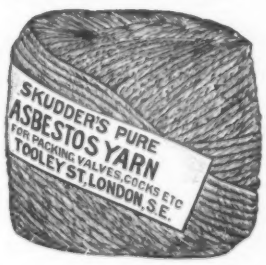

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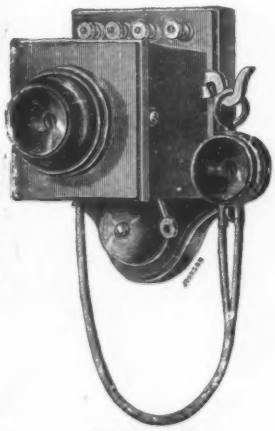
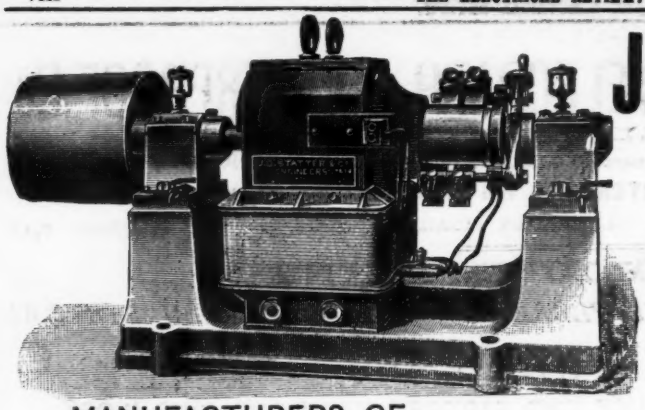


Fig. 79.



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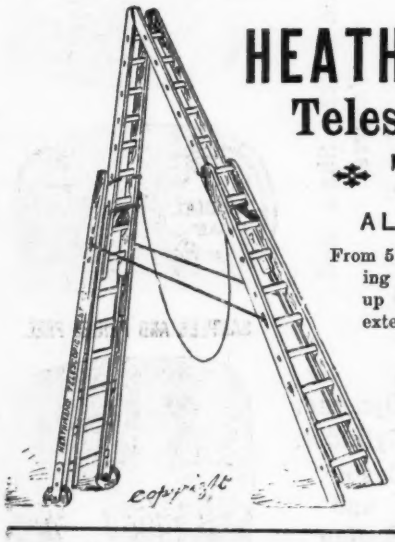

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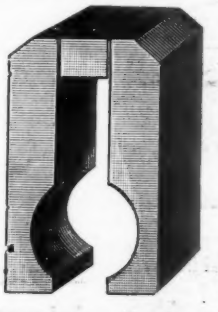

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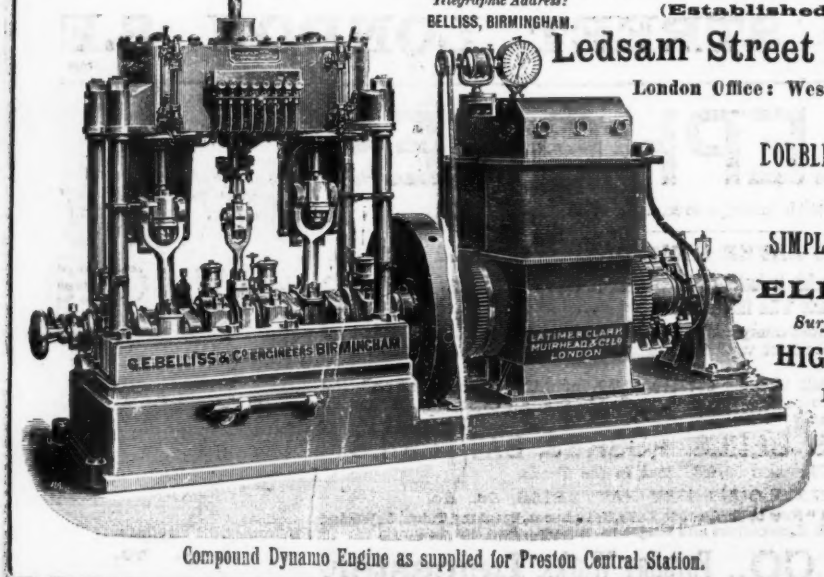

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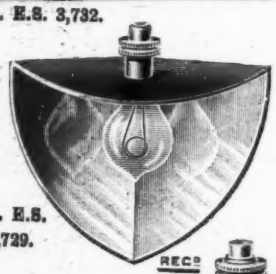

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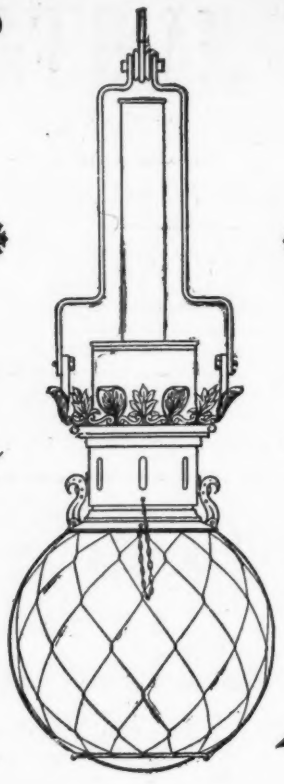

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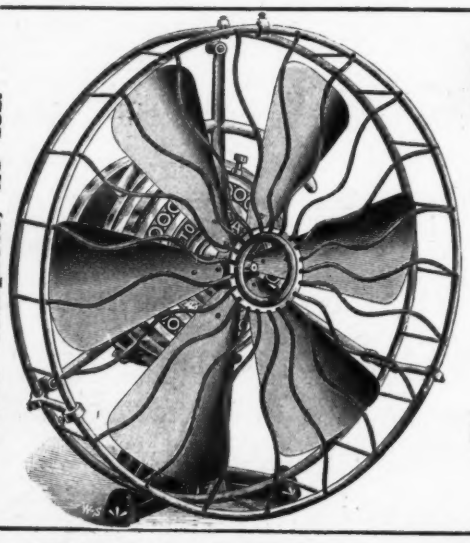

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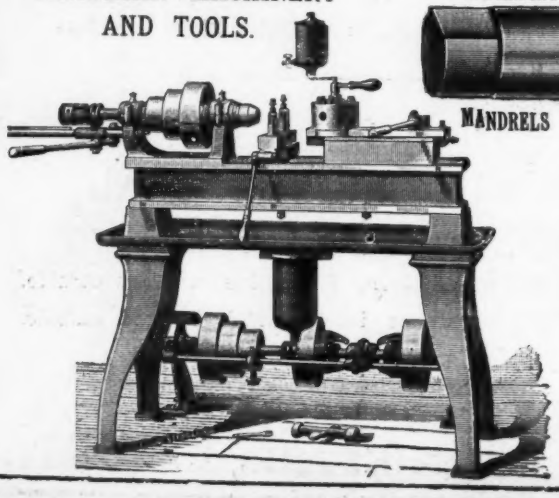

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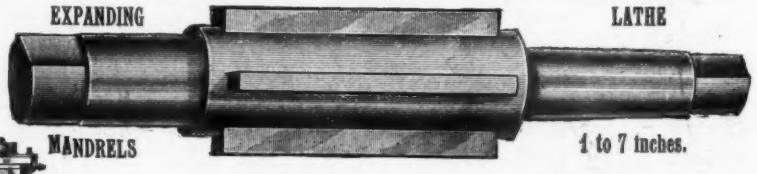

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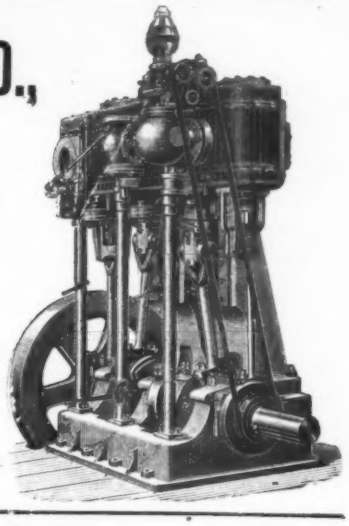

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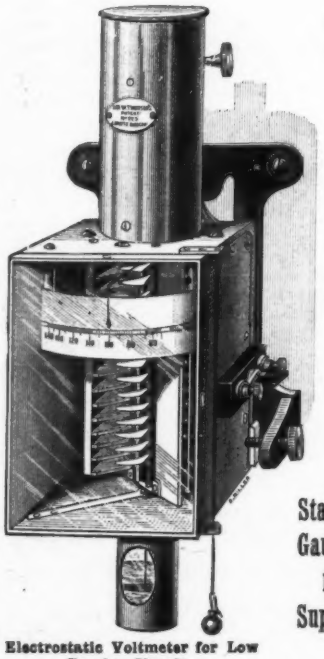

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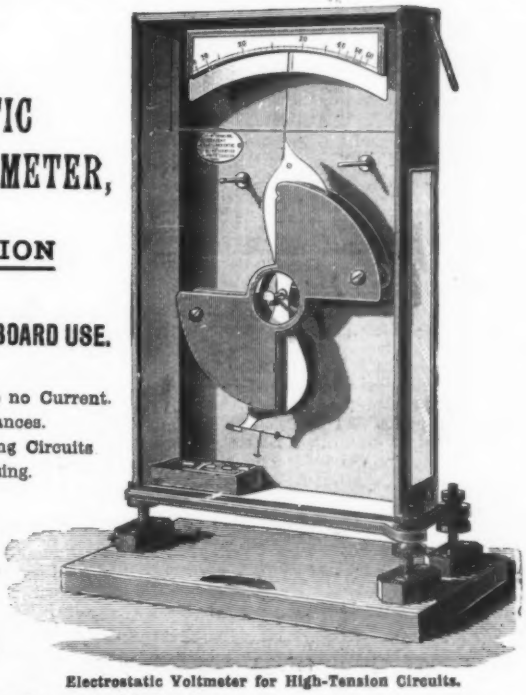

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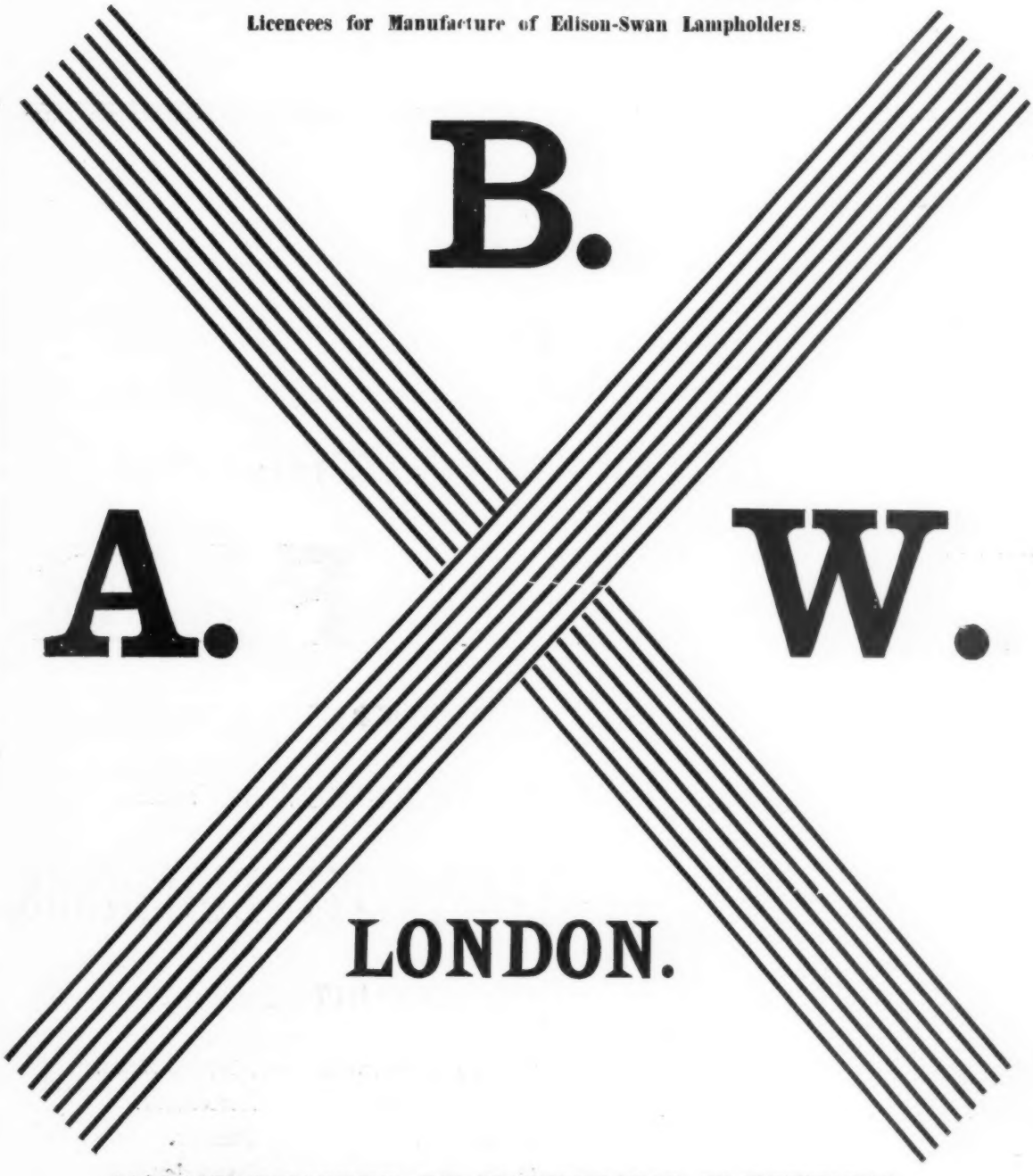

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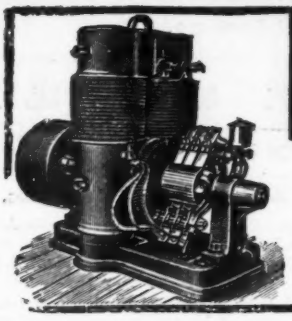

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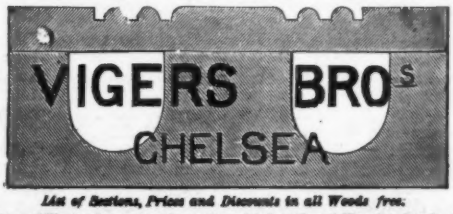

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WILLIAM RUSTON,
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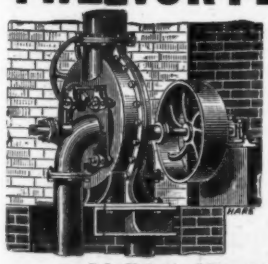

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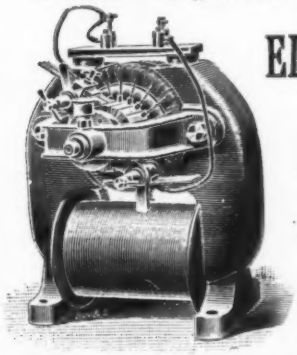

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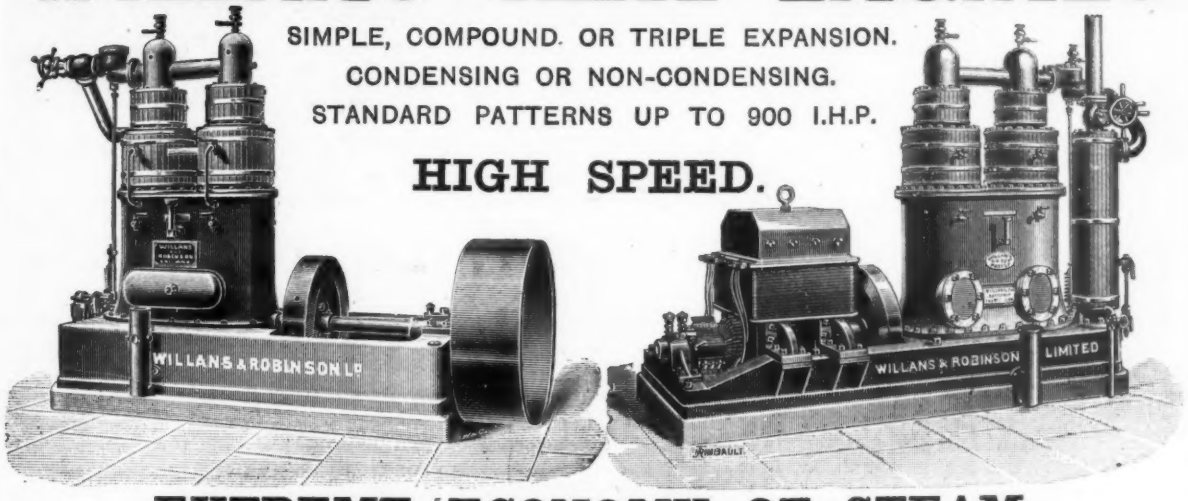

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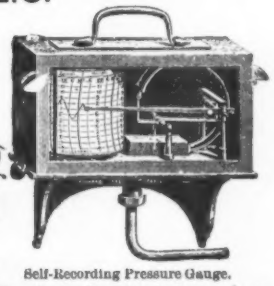

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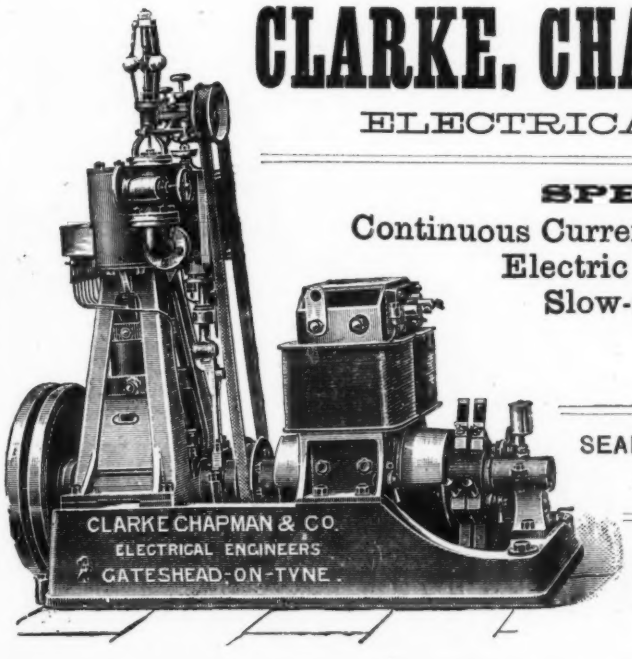

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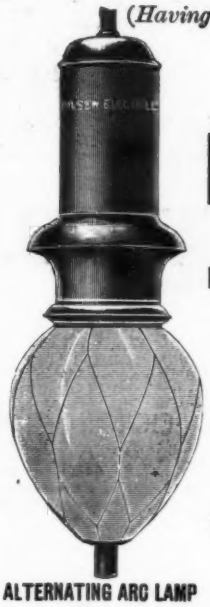

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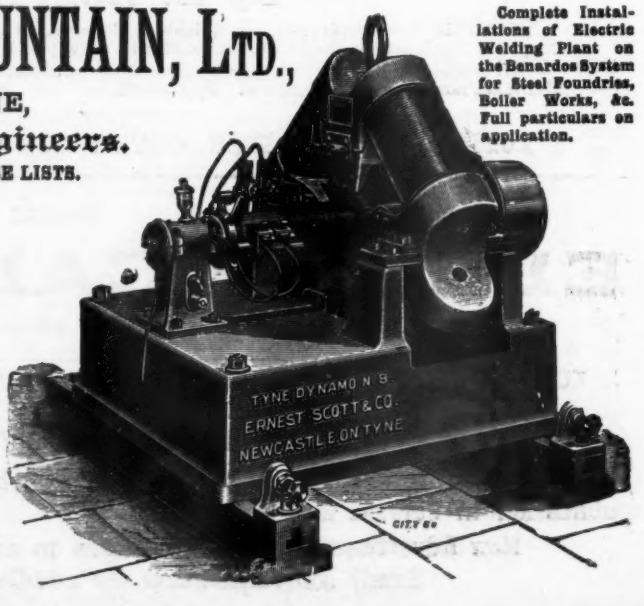

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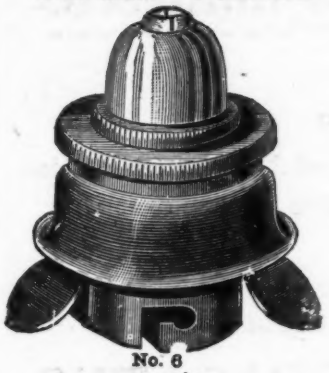

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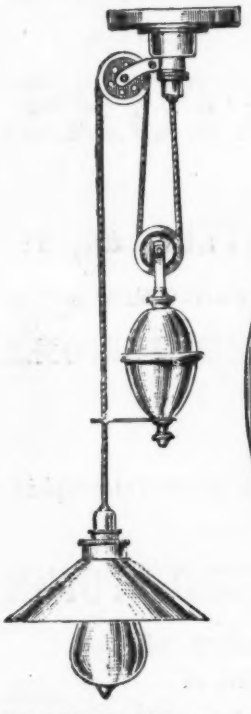

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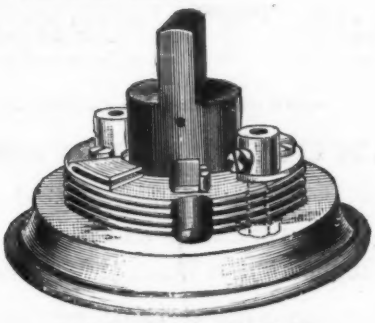

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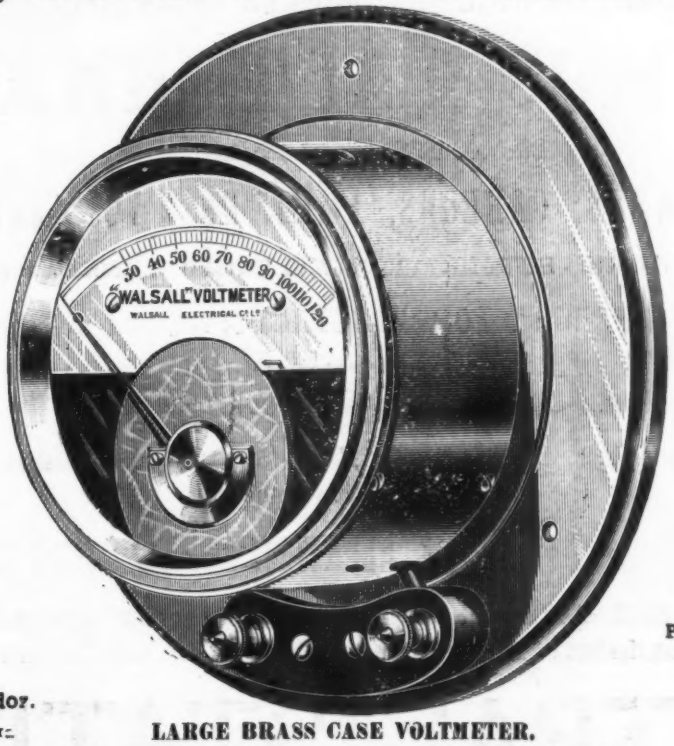

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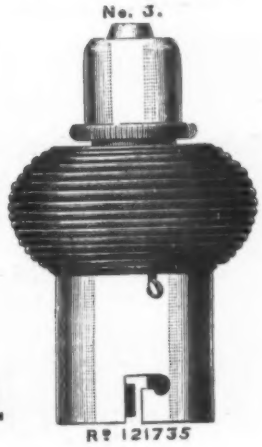

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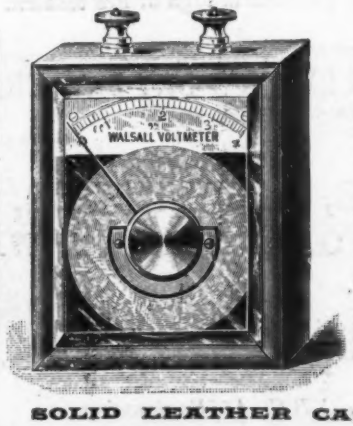

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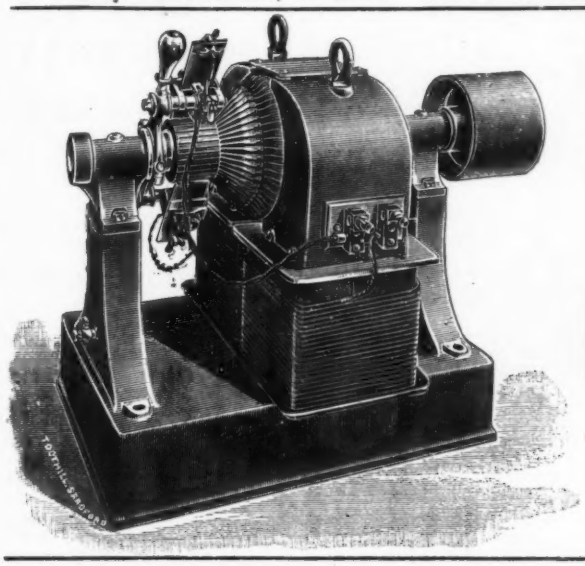

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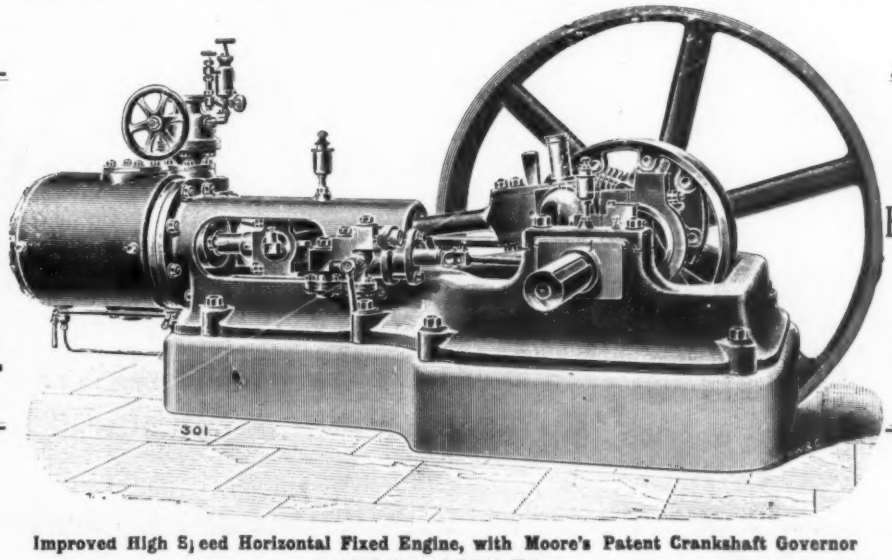

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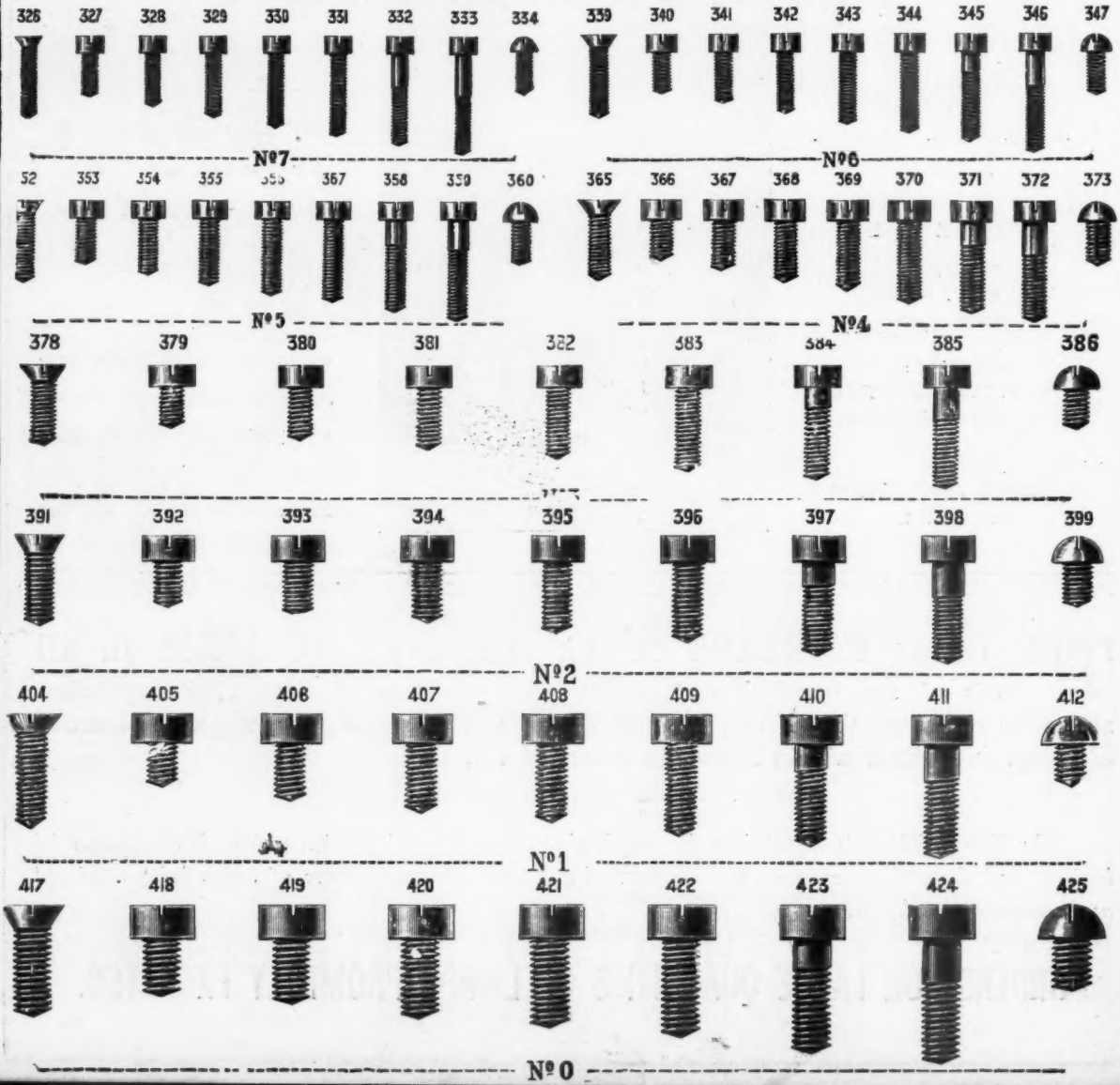

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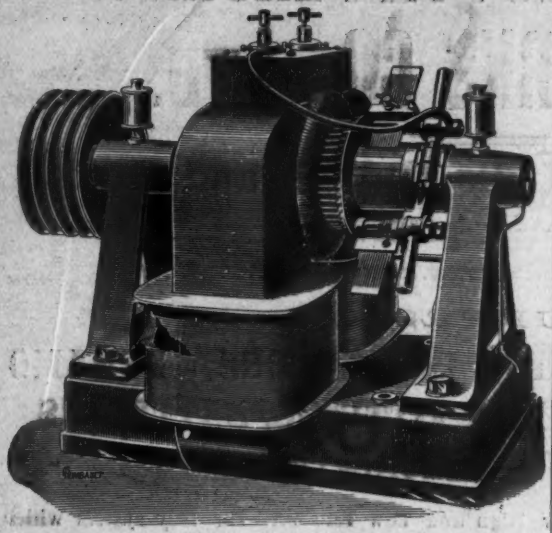

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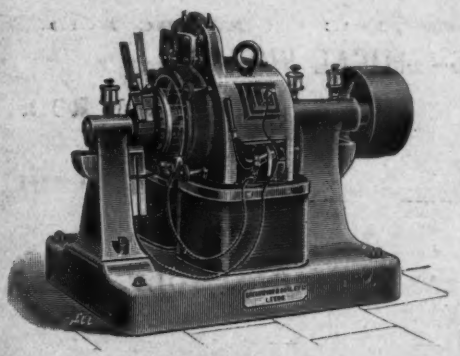

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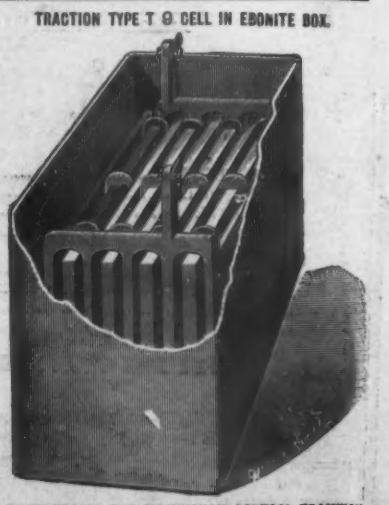

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NOT AFFECTED BY VINEGAR OR HYDROCHLORIC OR ACETIC ACID.

SPECIALITIES IN EBONITE FOR CHEMICAL WORKS.

LATORS, BATTERY CELLS, SPEAKING TUBES, SHEET and ROD. SURGICAL APPLIANCES, PHOTOGRAPHIC ARTICLES, SCREW STOPPERS, PUMPS.

GUTTA PERCHA.

TUBING, BELTING, BUCKETS, BOSSES for FLAX SPINNING, GOLF BALLS, SHEET, and TISSUE.

ESTIMATES AND PRICE LISTS ON APPLICATION.

HEAD OFFICES.

106, CANNON ST., LONDON E.C.

WAREHOUSES.

100 TO 104, CANNON ST., LONDON, E.C.

BRANCHES.

MANCHESTER	4, Fountain Street.	DUBLIN	15, St. Andrew Street.
LIVERPOOL	54, Castle Street.	PORTSMOUTH	49, High Street.
GLASGOW	8, Buchanan Street.	BRISTOL	28, Clare Street.
BRADFORD, YORKSHIRE	1, Tanfield Buildings, Hustlergate.	NEWPORT, MON	119, Dock Street.
SHEFFIELD	64a, High Street.	CARDIFF	Pierhead Chambers, Bute Docks.
BIRMINGHAM	27, Albert Street.	NEWCASTLE-ON-TYNE	6, Neville Street.
BELFAST	33, High Street.	COVENTRY	2, Vicar Lane.

WORKS.

SILVERTOWN, ESSEX. PERSAN-BEAUMONT, FRANCE.

TELEGRAPH ADDRESSES.

HEAD OFFICE—"Silvergray, London."
BRANCHES—"Silvergray" (followed by Name of Town).

WORKS—Silvertown, "Grayallver, London."
Persan-Beaumont, "India, Beaumont-sur-Oise."

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